ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XLII. No. 5.

TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK..... 65
The Pumping and Power Station of the East Jersey Water Co., at Little Falls, N. Y. (with two-page plate and other illustrations) 66
The Sanitary Conditions and Requirements of Havana, Cuba 68
A Novel Form of Corrugated Expansion Joint for Steam Piping (illustrated) 70
The Berlin Combined Trolley and Conduit Electric Railway (illustrated) 71
Test of Pumping Engine at Chicago, Ill..... 75
A Difficult Piece of Foundry Work (illustrated).... 76
A Carrier for Hauling Wire Through Conduits (illustrated) 77
A Simple Design for a Timber Roof Truss (illustrated) 77
A Simple Rivet Heating Furnace (illustrated)..... 77
The Hastings Tunneling Shield (illustrated)..... 77
A Tile Roof Without Sheathing (illustrated)..... 79
Rotary Transformers and Storage Batteries for Long-Distance Transmission 79
EDITORIAL NOTES 72
The Proper Name for Vehicles Propelled by Mechanical Motors—The Water Rates Dispute at Chattanooga, Tenn.—Recent Court Decisions Respecting Water Pollution—The Court Decision Respecting Free Water in Detroit.
EDITORIAL:
What Had Best Be Done with the New York State Canals?—A Symposium 73
LETTERS TO THE EDITOR 74
The Protection of Overhead Bridges from Locomotive Gases—Apparatus for Taking Continuous Blue Prints.

THE TRAFFIC OF THE NEW YORK STATE CANALS shows an improvement so far this season over last year's figures. The comparative statistics of the two years which appear in press dispatches sent out from Albany, N. Y., are as follows:

	1898. Tons.	1899. Tons.
April	.....	65,113
May	266,013	401,328
June	487,628	556,089
July, first week	110,387	123,021
Second week	94,837	125,039
Third week	148,552	135,402
Total	1,107,617	1,406,811
Increase		298,194

The canals opened on April 22 this year and on May 8, in 1898, so that there are two weeks more of navigation this year than last. From April 22 to May 1 this year 63,113 tons were carried, and from May 1 to May 8 about the same number of tons, but even with these advantages of the present season over that of 1898 there is an increase of more than 170,000 tons. The increased traffic is due in the main, it is considered, to the betterment of the business conditions, which has resulted in larger shipments from the West. A disagreement of some of the grain elevator operators at Buffalo and the exclusion of several of them from the pool is said to be another condition having an influence on the increase. The increase of traffic has not in any way been the result of the canal improvement work. That can exert no influence until it is completed.

THE OHIO STATE CANALS are the subject of a recent report by the Ohio State Board of Public Works, which shows that the expenditure for 1898 amounted to $179,950, while the receipts were only $79,814, making a loss of $100,134. The canals have deteriorated into mere ditches, and appear to be of little use now, except for political purposes, but the Board tries to make a better showing by a statement to the effect that since 1825, when the state canal system was first organized, the receipts have been $16,493,641, and the expenditures only $11,104,872, leaving a profit of $5,388,769 (or $72,820 per year), while the state still owns 582 miles of canal and 30,000 acres of reservoirs.

THE ST. CLAIR & ERIE SHIP CANAL is again being heard of, and the daily press is publishing rumors to the effect that work is to be commenced shortly and completed in two years. The proposed canal will be 13 miles in length, with dredged approaches, bringing the total distance from Lake St. Clair to Lake Erie up to 32 miles, while the present route by way of the Detroit River is 111 miles in length. The canal will be mainly in firm blue clay, and will have a width of 72 ft. on the bottom, side slopes of 1 on 2 and a depth of 31 ft. of water. The cost is estimated at $5,520,000. There will be four railway drawbridges and three highway drawbridges; also passing places at intervals, a guard gate at the upper end, and a harbor of refuge at the lower or Lake Erie end. No locks will be required, the fall being only 3 ft. The time is assumed to be five hours by the canal, as compared with eleven hours by the present route, and the projectors assume an annual traffic of 20,000,000 tons, giving an income in tolls amounting to $660,000.

THE MOTT HAVEN CANAL in New York is in a dilapidated condition, and but little used, and it is now proposed to fill it in. It extends from the Harlem River, opposite 131st St., to 144th St., about 3,000 ft. This channel the town of Morrisania, in 1868, allowed two individuals, Wm. E. Ryder and F. H. Conkling, to build through their property, on condition that they keep it dredged and bulkheaded, and the bridges over it in repair; and if they failed to do this they were to be compelled to fill it in at their own expense. The conditions appear to have been unfulfilled.

THE PARTIAL ABOLITION OF WATER RATES at Detroit has been declared unconstitutional by the Circuit Court of Michigan. The last legislature passed an act abolishing the water board and transferring the property under its care to the board of public works. The act also provided, among other changes in the method of raising money to meet the expenses of the water-works, that after July 1, 1900, the estimated cost of all water used for strictly household purposes should be raised by general taxation. The amount to be so raised was to be determined annually by a board composed of various city officials. The water board refused to step out of office on July 1 last, claiming that the act in question was invalid, for a variety of reasons. One of these reasons was that the constitution guarantees to the voters of the city the right to say, either by themselves or their representatives chosen for that purpose, what sums should be raised by taxation, whereas this act vested the same powers in a board made up of various city officials, chosen for quite different purposes. The circuit court maintains that this view is correct, and declares the whole act to be unconstitutional. The case will go to the State Supreme Court. The provisions of the act relating to water rates were reviewed editorially in our issue of June 29, 1899, and further editorial comments on the subject will be found in this issue.

A WATER POLLUTION SUIT IN PENNSYLVANIA has been decided against the offender, the Superior Court reversing the decision of the Court of Quarter Sessions of York county. The suit was brought in behalf of the York Water Co. against an individual who allowed the sewage wastes from his premises to discharge into a stream above the intake of the company. The company supplies water to York, a place having a population of over 20,000 by the census of 1890. The offender held that the stream in question was a common sewer for the borough of Glen Rock, and that he was required to drain into it by the ordinances of the borough. The lower court decided in favor of the defendant, but the Superior Court declared the pollution an unjustifiable nuisance and ordered a new trial in the lower court. A part of the decision, with comment, is given in our editorial columns.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a derailment on the Chicago & Northwestern Ry., just east of the Des Moines River Bridge, near Boone, Ia., on Aug. 1. The train was a fast mail train and was rounding what is known as "the Kate Shelley Curve" when it jumped the track, wrecking the engine and all the cars and killing four persons and injuring eight others.

ANOTHER VERY SERIOUS RAILWAY ACCIDENT was a collision on the Erie R. R., July 29, between a westbound passenger train and the wreck of an eastbound freight train which had blocked both tracks just as the passenger train was approaching. The accident occurred about 11 p. m., two miles east of Lackawaxen, N. Y. During a heavy storm a landslide occurred which blocked the eastbound track. Before the obstruction was discovered the freight train ran into it, and 22 of the 55 cars were derailed and thrown over upon the westbound track. A brakeman ran ahead, knowing that the express was due, but before he had gone far that train came up, running at high speed, and dashed into the wreckage. The engine, baggage and mail car, combination buffet and smoking car and two Pullman sleeping cars were derailed and wrecked. The other two cars were not damaged. The cars caught fire, and the four derailed cars of the passenger train, and nine freight cars, were destroyed. The engineman and fireman of the passenger train were killed, and 27 of the passengers and trainmen were injured, but none seriously.

A TUNNEL CAVED IN on the Baltimore & Ohio R. R., near Cambridge, O., July 27. The tunnel is 700 ft. long, and it has caved in for about 300 ft. Traffic has been diverted over the Cleveland & Marietta Ry. until the main line is again open.

A TEST OF A 36-IN. WATER METER was made on July 19 at the factory of the National Meter Co., 42d St. and 1st Ave., South Brooklyn. The meter was one of three of the Gem type (two 36-in. and one 24-in.) being made for the water department of Jersey City, partly as a check on the Venturi meters which are used by the East Jersey Water Co. to measure the water supplied by it to Jersey City. A permanent plant for testing large meters has been built at South Brooklyn. A 50,000,000-gallon pump lifts water a few feet to a stand-pipe, from which it flows through the meter and into a brick conduit 12 ft. wide and more than 6 ft. deep, in which an 8-ft. weir is placed. From the weir the water returns to the pump. The head of water on the weir is determined both by a hook and an automatic gage. In the test last week a 30-HP. Nash gas engine was used, capable of operating the pump at the rate of 12,000,000 gallons a day. The testing plant was designed and built by Messrs. Lewis H. Nash, M. Am. Soc. M. E., and J. H. Norris, of the National Meter Co. At the test the company was also represented by Mr. C. D. Ward, M. Am. Soc. C. E., 702 St. Nicholas Ave., New York city. Jersey City was represented by Mr. C. A. Van Keuren, Chief Engineer of the Street and Water Department of that city, and by Mr. A. S. Tuttle, M. Am. Soc. C. E., Municipal Building, Brooklyn, who will report the tests for Jersey City. Mr. John C. Kelley is President of the National Meter Co., New York city. On the invitation of the company, a large number of hydraulic engineers and water-works officials from this and adjoining states were present at the test, and afterwards enjoyed a collation in the large drafting room of the company. The results of the test are promised for a later date.

THE NAVIGATION OF THE CHICAGO RIVER is to be extended about two miles, along the North Branch, from Belmont Ave. to Lawrence Ave., if the plans of certain real estate firms are followed. The plan is to widen and strengthen the river, making a channel with 15 ft. of water. Navigation now ends at Belmont Ave., and above this point all the bridges are fixed structures.

THE IMPROVEMENT OF THE VOLGA RIVER, in Russia, is proposed by Mr. Poletaeff, an engineer who is now engaged in improvement work on the Petroffsk River. He considers that dredging will not suffice to maintain channels in the broad, shallow sections, owing to the caving of the banks and the constant accretion of deposit. He proposes to pass the bars by making canals of ordinary width about 36 ft. deep on both sides of the river. Taking the total length of these bars to be 266 miles, the cost of these canals will not exceed $10,000,000. To prevent the formation of further bars by the widening of the river bed, it would be indispensable to plant willows on the banks, which, reckoning the height of the embankments at 12 ft., would not cost more than $6,000,000. The cost of the whole undertaking would not exceed $20,800,000, and the engineer considers that it could be accomplished within ten years.

THE TRIPLE-VALVE PATENT INFRINGEMENT charged against the New York Air Brake Co. by the Westinghouse Air Brake Co. has been decided in favor of the defendants by the United States Court of Appeals. The decision was handed down on July 18. The Westinghouse company some time ago brought suit against the New York company for infringement of two patents on triple valves, claiming that the valve of the latter company, whereby the train pipe was vented to the atmosphere in emergency applications, was an infringement of Westinghouse patents. The question at issue was the right of the defendants to use this triple valve which vented into the atmosphere and the decision of the circuit court was in favor of the defendants. The suit just closed was an appeal from the previous decision.

WORK ON THE EAST BOSTON TUNNEL has been started by the Boston Transit Commission. It is stated that the work begun is for an experimental section, wholly of concrete, large enough for a double track. The work was begun at Maverick Square. The tunnel will extend beneath the water and connect East Boston with the present subway system.

LAKE SHORE PROTECTION for the frontage of Lincoln Park on Lake Michigan, Chicago, is proposed by Mr. W. T. Casgrain, C. E. The existing concrete sea-wall has been undermined and damaged by storms, while the filling between the foundation piles has been washed away. He proposes to drive a row of piles, 14 ft. 6 ins. from the foundation piles, supporting a wall of triple-lap sheet piling, in front of which will be dumped large rip-rap stones. Horizontal brace timbers, 10 × 10 ins., 14 ft. long, will extend between the protection and foundation piles, and these piles will be tied together by 1¼-in. rods. The space, 14 ft. 6 ins. wide, will be filled with gravel and broken stone in 12-in. layers. This would be finished off to a slope and paved with large stone blocks laid in cement. The cost is estimated at about $120,000, or $30 per lin. ft. Including filling in behind the wall, laying drains, sidewalks, and a roadway, with the necessary repairs to the wall, would bring the total cost of the improvement to about $150 per ft.

THE PUMPING AND POWER STATION OF THE EAST JERSEY WATER CO., AT LITTLE FALLS, N. J.

(With two-page plate.)

The East Jersey Water Co. and its allied interests have contracts for supplying water in Jersey City, Paterson, Passaic and numerous smaller places in Essex and Hudson counties, N. J. Many of the cities and towns so supplied are dependent on the surplus from the Pequannock supply for

FIG. 10.—HEAD RACE BENEATH MORRIS CANAL, WITH SCREEN, PUMP AND BOILER HOUSES BEYOND.

Newark, developed by the company in 1890-2, but all of which becomes the property of Newark in September, 1900. The contract with Jersey City is a temporary one, designed to tide over the city until the new supply from the Rockaway, recently contracted for, is available. Paterson and Passaic are supplied from the Passaic River, immediately above the Great Falls, at Paterson, but the supply from this point is not above suspicion. In October, 1897, the East Jersey Water Co. began to develop a new source of supply at Little Falls, N. J., about five miles above Paterson. The plant is a combination of water and steam power, the pumps being between the turbines and the steam engines and so connected that either water or steam power, or both, may be used. For a part of the year little or no steam will be required, but there are times when nearly the whole present available flow of the river would be needed to supply the population which in a few years may be dependent on these works. With proper development the minimum flow of the river may be greatly increased.

The drainage area of the Passaic River at Little Falls is 772 sq. miles. Records extending over 17 years show a rainfall varying from 70.88 to 35.70 ins. The river flow, as gaged at Little Falls and stations a few miles below, from 1877 to 1893, inclusive, was above 3.65 cu. ft. per sec. per sq. mile, an average of 47 days yearly; above 4.86 cu. ft., 29 days yearly; above 9.72 cu. ft., 4.3 days yearly; and above 14.6 cu. ft., only eight days during the whole 17 years. In 1882 occurred what was probably the highest flood of the century, reaching a total flow of 19,100 cu. ft. per sec. at Little Falls, or about 25 cu. ft. per sq. mile per sec. For the whole Passaic River, most of which is above Little Falls, the average daily flow in the driest month of the records, is 127,000 gallons per day per sq. mile, and 110,000 gallons for the driest day. With ample storage it is estimated that the Passaic River will yield 666,000 gallons per sq. mile of drainage area per day during the driest periods. This would be 514,000,000 gallons a day at Little Falls, assuming that none of the runoff was diverted above this point. As a matter of fact, the Newark supply is guaranteed to give 50,000,000 gallons a day, and the new works for Jersey City call for 70,000,000 gallons as a possible maximum, all from the Passaic drainage area. It is estimated that for an average of nine months per year the Passaic will yield 4.5 theoretical HP. per 1 ft. fall for each 100 sq. miles of drainage area from which no diversions are made, and 2.2 HP. during the driest month of the driest year.*

As stated above, the actual drainage area above Little Falls is 772 sq. miles. A large part of the flow of two important highland tributaries is already appropriated, including 63 sq. miles of drainage area above the Macopin intake on the Pequannock, and 118 sq. miles above Boonton, the location of the dam on the Rockaway for the new supply of Jersey City. It will be some years before storage is provided to conserve the full flow of the 181 sq. miles in these two drainage areas, so calculations on available flow and power at Little Falls for a number of years to come may safely be made on the basis of 600 sq. miles. The present plans, so far as announced, do not provide for storage above the intake. A storage reservoir of about 150,000,000 gallons capacity is being built at Great Notch, near by, into which water will be pumped, but this reservoir is too small to have much bearing upon the total yield of the river at Little Falls. The figures given above indicate that during the driest month the total yield from 600 sq. miles of Passaic drainage area would be 76,000,000 gallons a day, and on the driest day only 66,000,000 gallons. Actually, the yield might be less, for the 181 miles of highland drainage deducted has a yield above the average for the whole area. Making a liberal allowance for this deduction of part of the most prolific drainage area, the available yield, with ample storage, may be placed at 500,000 gallons per sq. miles per day, or a total daily amount of 300,000,000 gallons available for power and water supply. It is idle to speculate upon the division of water between power and public water supply, and the extent to which the minimum flow will be developed by storage. Obviously, this will depend largely upon the demand for water for public supplies and the prices which it will command.

*The figures in this paragraph are from the report on "Water Supply, Water Power," etc., by Mr. C. C. Vermeule, being Vol. III. of the Final Report of the State Geologist of New Jersey.

FIG. 11.—VIEW OF 12-FT. STEEL PENSTOCKS.

It must also be remembered that the deduction of so much as 181 sq. miles, on account of diversions in the Pequannock and Rockaway, does not necessarily correspond closely with the actual future status of the case, at least for years to come. It may be added here that the available head for power at the new works will be 35 to 38 ft.

The rocks found at Little Falls belong to the triassic period. There are deposits of trap rock here, forming part of the large trap rock belt which traverses the State of New Jersey and extends from the western part to the Palisades on the Hudson River. The upper stratum is very near the surface, and is crystallized almost vertically in long needles or blades. The second deposit of trap is more compact and close grained. It rests immediately on a stratum of brownstone of superior quality and considerable thickness. Both trap rock and brownstone have been extensively used in the construction of the plant. Trinity Church, New York city, is built of this same brownstone, from a neighboring quarry.

The head race canal was excavated in the lower trap stratum, and all the buildings and structures are founded on the same rock, except the lower end of the power house, which is founded on brownstone.

The illustrations on the two-page engraving and in the text give a comprehensive idea of the work at Little Falls, which consists of a head race canal, with a gate-house and screen-house at either end, and a power and a boiler house. The general plan of the works is shown by Fig. 1. The head race canal starts from a pond already formed by the dam of the Beattie Manufacturing Co., and passes alongside and beneath the Morris Canal. The bottom of the head race canal is level, except for a fall of 7 ft. in a length of about 100 ft. at the lower end; it is about 1,400 ft. long and 60 ft. wide, except as it crosses under the Union St. bridge and at the culvert, where it is 50 ft. wide. As it reaches the intake gate-house it forms

a forebay 76 ft. in width. It carries some 8 ft. of water. It is designed to give a cross-sectional area of about 480 sq. ft., and a carrying capacity up to 1,500 cu. ft. per sec. Its side walls on the Morris Canal side are of brownstone, except at the ice level, where they are of granite, as is shown by the view, Fig. 12. The retaining walls on the

FIG. 12.—UPPER END OF HEAD RACE CANAL, SHOWING SPECIAL MASONRY COURSES, MORRIS CANAL, AND TRAP ROCK RETAINING WALLS.

river side of the race are of trap rock, excavated from the canal, as is also shown by Fig. 12. All these walls were laid dry.

As mentioned above, the head race canal has a gate house above and a screen house below. The upper or head gate house has a heavy granite substructure with brownstone superstructure containing the head gates and the machinery for operating them.

These gates, six in number, are operated in pairs by a 3-HP. Crocker-Wheeler direct-current motor, and can also be operated by hand by means of a suitable device. The gates are 8 × 8 ft. and 10 ins. in thickness. The entrance to the canal is protected by a boom 84 ft. long. This boom is supported in the center by a triangular steel boom post anchored in concrete.

The construction of the head race was complicated by its proximity to the Morris Canal, until the latter turns and crosses over the Passaic River on an arched masonry bridge. At the upper end of the race an embankment and retaining wall were necessary to support the Morris Canal, as shown by Fig. 2 on the inset sheet and the view, Fig. 12, in the text. Where the canal turns, the head race is carried beneath it through a culvert or series of culverts about 115 ft. long, shown by Figs. 3 and 4, and the view, Fig. 10, built partly on a tangent and partly on a curve of 133.47 ft. radius. There are five channels, each 10 ft. wide, and 8.16 ft. high, to the springing line, separated by 30-in. walls. The dividing walls are of Munson granite, laid to ¾-in. joints, all stones laying the full width of the pier. The culvert arches are of brick in Portland cement. They were covered with three thicknesses of tar paper, successively laid in hot asphalt and thoroughly cemented and jointed with the same material. The leakage above the arches is conducted through 5-in. drains laid in the haunches to weep pipes at each end of the culvert. The underside of the arches is perfectly dry, after one year of service.

The intake gate house comprises the dam, where the penstocks and other conduits begin, a double set of steel racks, and the house proper, which contains the screens for the supply pipes. Immediately above the intake dam is a 50-ft. wasteway emptying into the Passaic River. Both gate houses have an interior finish of red pressed brick.

The racks and one of the 12-ft. steel penstocks are shown by Fig. 5, while a view of the racks is shown by Fig. 13, and of the three penstocks, by Fig. 11, both in the text. The plan of the penstocks, and also of the intake gate house and upper end of the supply pipes leading to the pumps, is shown by Fig. 6. Fig. 7 shows the general arrangement of the power and boiler houses and piping. Fig. 8 is a section of the power house on the line X Y of Fig. 6. It also shows one of the branches leading from the penstock to the turbine, each of which is provided with a 72-in. double disk gate.

The 12-ft. penstocks are reduced to 11 ft., where they pass through the intake dam. There are three of these penstocks, each supplying three turbines, the pipes being diminished in size below each branch. A 36-in. penstock leads from the gate house to a turbine designed to drive a 100-HP. dynamo. The dynamo is also provided with a Ball engine, both the engine and turbine being connected on the same shaft by friction clutches. This dynamo will supply current to operate the 16-ton traveling crane, shown in Fig. 8, and to lift the gates in the head gate house, and will furnish light for all the buildings.

Two 66 and one 48-in. steel supply mains lead from the intake dam, the 66-in. pipes supplying the pumps, and the 48-in. main being intended as a low service gravity conduit for the supply of the cities of Paterson and Passaic. Provision is also made for four 48-in. force mains. The available space for piping being limited, the latter is crowded together in the manner partially indicated at the right of the section, Fig. 8. The penstocks and other conduits are of ⅜-in. steel, the lengths being tapered so the small end of one slips into the large end of the other, the small end being of the nominal diameter of the pipe.

The power house is a substantial brownstone structure with inside finish of buff pressed brick and a dado of enameled brick extending to a height of 6 ft. above the floor. The roof trusses are supported on steel columns built in the masonry. These columns also support the girders on which rests the electric crane.

The site for the power house has been reclaimed from the original river bed. The upper part of the house is built on the site of an old pot hole, formed ages ago, before the falls had receded to their present location. The whole power house is founded on solid rock. The boiler house is directly back of the power house, and near the cliff.

The main floor is at Elev. 147.5 ft., and supports the boilers. The building will be extended later on so as to give room for two batteries of boilers of 2,500-HP. each, operated by forced draft. One battery is now being installed. The space between the two batteries of boilers is occupied by the blowers and feed pumps. At the back of the building there is a coal bin of 500-ton capacity, with room for another. At the rear of this coal bin is a retaining wall 35 ft. in height, to retain the earth filling between the cliff and the boiler house and to support the tracks which will take the coal cars to the bin. This retaining wall extends to the intake dam and the part built between the latter and the boiler house is on a curve of 25° radius.

Just below the power house, and in line with the four 48-in. conduits, is a cross-connection chamber, or hydraulic switch-board (Fig. 9), where the different conduits are inter-connected to permit any one to be supplied from any other one. The connections are of 36-in. pipe. A 48-in. check-valve is placed in each conduit, and just below the chamber there is a Venturi meter on each pipe line. The first conduit decreases to a diameter of 42 ins. just below the chamber and continues of that size to Paterson, to supply the low service of that city. The second conduit increases in size to 51 ins. just below the chamber, and is now being laid from that point to connect with the Kearney extension conduit of the East Jersey Water Co., at Belleville, a distance of eight miles.

FIG. 13.—VIEW OF STEEL RACKS AND GATES IN HEAD RACE CANAL, AT INTAKE OR SCREEN HOUSE.

All brownstone and trap rock for backing and other purposes was quarried a few hundred feet from, and on the site of, the power house. The grante, which is a hornblende, came from near Middletown, N. Y. Several thousand loads of sand were obtained from the river close by. Atlas cement was exclusively used on the works. A spur

track, about a mile long, from the Delaware, Lackawanna & Western R. R. was used for bringing in supplies.

Below the power house the river channel to a width of about 100 ft., and for a mile in length, is being lowered from 1 to 6 ft., to bring it down to Elev. 114, and thus to increase the available fall.

The plans for the turbines, pumps and engines were made by Prof. A. Riedler, of Berlin, Germany, but they have been modified in some particulars, with his consent, to comply with American practice. The machinery is being built by the Dickson Manufacturing Co., of Scranton, Pa. At the start there will be three 10,000,000-gallon high pressure and one 20,000,000-gallon low pressure pumps, all cross-compound duplex, and a 2,500-HP. steam

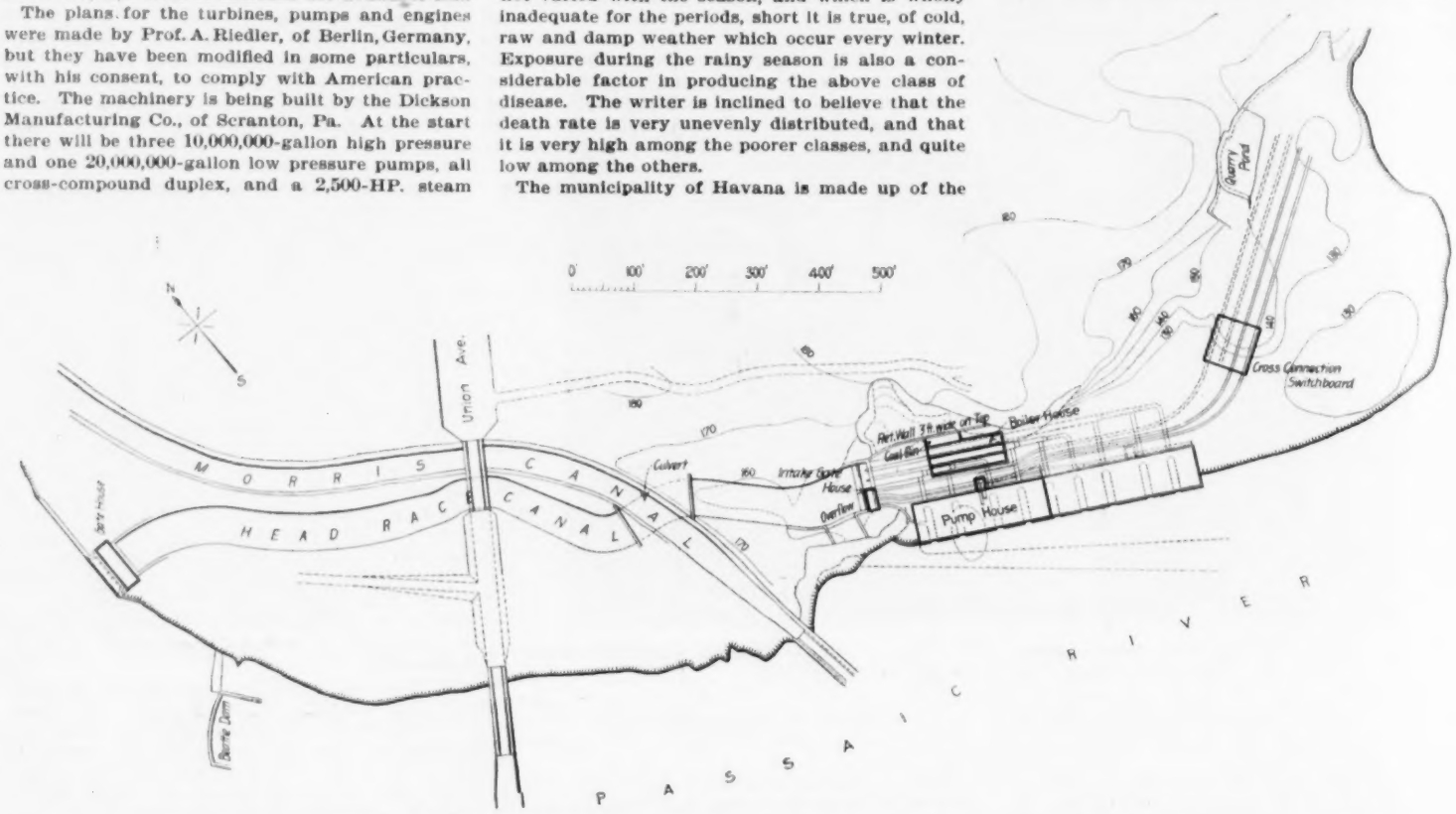


FIG. 1.—GENERAL PLAN OF POWER DEVELOPMENT AND PUMPING STATION OF THE EAST JERSEY WATER CO., AT LITTLE FALLS, N. J.
Clemens Herschel, M. Am. Soc. C. E., Chief Engineer; T. A. Gillespie Co. and Dickson Mfg. Co., Contractors.

plant. The engines are of the flywheel type, making 80 revs. per min., and both they and the turbines are direct-connected to the pumps, but so arranged that either steam or water power, or both, may be used.

The plan and section of the pump house, Fig. 6, show space for four sets of turbines, engines and pumps. Provision has been made for extending the pump house to more than double this capacity, there being five wheel pits in the proposed extension.

We are indebted to Mr. Clemens Herschel, M. Am. Soc. C. E., M. Inst. C. E., Chief Engineer of the East Jersey Water Co., 2 Wall St., New York city, and to Mr. H. F. Labelle, M. Am. Soc. C. E., Resident Engineer, for courtesies shown and information given in the preparation of this article. The contractor for all the work except the machinery is the T. A. Gillespie Co., Havemeyer Building, New York City, and Pittsburg, Pa.

THE SANITARY CONDITION AND REQUIREMENTS OF HAVANA, CUBA.

By E. Sherman Gould M. Am. Soc. C. E.

The healthfulness of a city is pretty accurately determined by its normal death rate. Its sanitary condition is measured first by its natural advantages of site, soil and climate, and secondly, by the artificial aids created by its inhabitants. Of these latter the principal ones are an abundant and pure water supply, a good sewerage system, well paved streets and well drained and ventilated habitations. These artificial advantages are obtained generally through the medium of an intelligent, efficient and honest Board of Public Works.

The death rate of the city of Havana in 1893 was 33 per 1,000, and this probably is, or at least has been, about the average in years of ordinary healthfulness. This is a high rate and, as compared with recognized standards, classes Havana as an unhealthy city.

About 20% of the deaths may be attributed to pulmonary consumption. Yellow fever is endemic, and paludic fevers and rheumatism prevail. The large percentage of pulmonary diseases may be partially accounted for by the scanty clothing worn particularly by the poorer classes, which is not varied with the season, and which is wholly inadequate for the periods, short it is true, of cold, raw and damp weather which occur every winter. Exposure during the rainy season is also a considerable factor in producing the above class of disease. The writer is inclined to believe that the death rate is very unevenly distributed, and that it is very high among the poorer classes, and quite low among the others.

The municipality of Havana is made up of the city proper and a number of scattering suburbs, the principal of which are Cerro, Vedado, Principe and Jesus del Monte. The city proper covers an area of about 1,500 acres. As will be seen from any of the numerous maps of Havana, it forms a strongly marked peninsular, bounded on the west by the fine avenue called the Infanta, and on the south by the little river or brook Chavez. Its

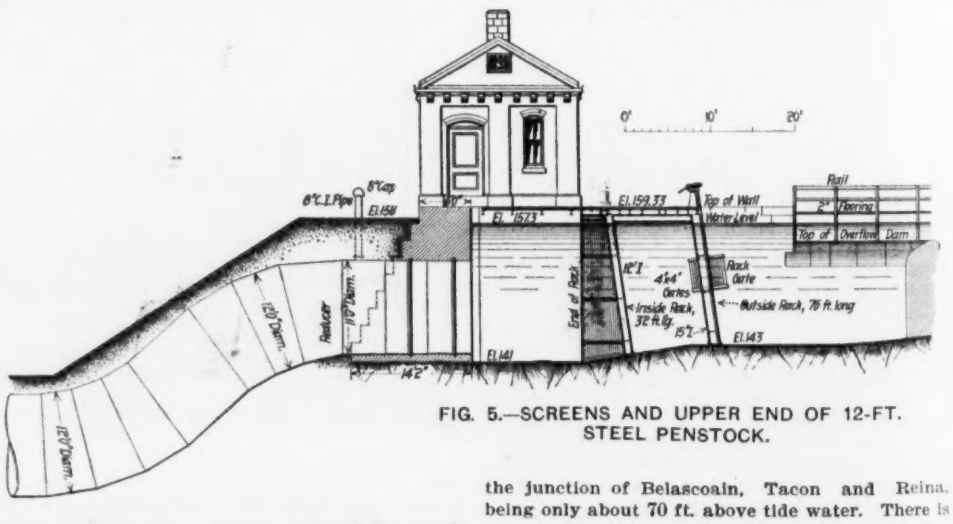


FIG. 5.—SCREENS AND UPPER END OF 12-FT. STEEL PENSTOCK.

population according to the census of 1887 was at that time 150,792 souls, or about 100 to the acre. This indicates very close packing, and represents the average of the two extremes to be met with in Havana —namely, on the one hand, broad avenues and spacious residences, and on the other narrow streets and small overcrowded tenements. The redeeming feature of the latter is the fact that owing to the mild climate all habitations are wide open to the atmosphere, ensuring abundant ventilation. If the sanitary conditions which exist in Havana were found in connection with the tightly closed habitations necessitated by a northern climate, the death rate would be appalling.

The population of the suburbs is much less dense. The area of those above enumerated is about 4,000 acres, and the population, in 1887, 37,844 souls. The entire population of the municipality in 1887 was therefore per census of that year, 188,636 souls. The census recently taken by Major Davis, M. D., U. S. V., gives 220,000, and his estimated death rate was about 30 per 1,000.

As regards topography, the city proper, as above defined, is very low lying, the highest point, near the junction of Belascoain, Tacon and Reina, being only about 70 ft. above tide water. There is an axis of maximum elevation running nearly due East from this point to the Campo de Marte, whence it deflects to the southward towards the San Jose wharfs of which we have heard so much lately. The soil upon which the principal part of the city is built is composed of a heavy impermeable clay, varied with low lying and more or less water-logged sections, and in certain localities, rock both hard and soft. These conditions are unfavorable to natural drainage by absorption.

The rainfall is not excessive, averaging about 50 in. per year. It is mainly concentrated in the few months which compose the rainy season the remainder of the year being comparatively dry. The precipitation occurs in torrential down-pours of short duration, rather than steady and prolonged rains. The climate though always moist is excellent, and during the winter months, delightful. The range of extreme temperatures is small and the average such that it is possible and even pleasant to keep doors and windows open during nearly every day of the year. Being just within the tropics, the beneficial effect of the N. E. trade winds is pretty steadily experienced.

The Bay of Havana covers an area of about 1,500 acres, the same as the city proper. About 500 acres of this are contained within the line of 20 ft. soundings. The entrance to the bay is long and narrow, having a length of about 4,500 ft., with a mean width of 1,250 ft., which is reduced at the two extremities to about 1,000 ft.

The rise and fall of tide is small, and is variously stated by different authorities. The extreme variation, on spring tides is probably not over 3 ft., and the mean may be about 18 ins. The rivers emptying into the bay are small and insignificant, so that the two most important agents in keeping a bay and harbor clean and clear, namely, heavy tidal exchanges and powerful streams pouring into it, are lacking in the present case. As a consequence the bay is in an extremely foul condition, which is of necessity becoming worse and worse, receiving as it does not only the discharge of the few sewers which Havana possessses but also, and worse, the surface wash of the whole surrounding territory. Deep soundings are found at a very short distance from the coast line on both sides of the entrance to the bay.

In a word, the natural sanitary advantages of Havana, apart from its fine climate, trade winds, and deep water sea front, are by no means of the first order.

Passing to the artificial advantages of the city of Havana, or those which modern civilization demands in all large aggregations of human beings, the case is very much worse. The ground floors of the houses consist generally of earthen tiles resting directly upon the soil which, as we shall presently see is saturated with filth and moisture. Cellars are unknown and the greater proportion of dwelling houses are of only one story, while dampness, darknesss and dirt, with their concomitant diseases, prevail. Here again, a broad distinction must be drawn between the condition and surroundings of the richer and the poorer people. Havana is a city of strong contrasts and widely separated extremes.

The water supply is excellent and abundant. It is the one redeeming feature of the sanitary condition of the city. The water is brought from the Springs of Vento, some seven or eight miles from the city and is distributed through the streets by nearly 90 miles of cast iron pipe. The pressure, however, is deficient in the higher portions of the city, and the need of a high-service system is already acutely felt. The waste of water is enormous, owing to careless habits, defective plumbing, and the lack of proper inspection and control.

The sewerage system is conspicuous by its abscence. There are, indeed, two or three large sewers having outlets at the water front of the city, which though originally intended merely to carry off storm-water, have since been connected with the house drains. There are also a number of so-called sewers which appear to have no outlet at all, forming what have been aptly called "elongated cesspools," with which the house drains connect. No official plans exist showing the location or character of these different sewers.

When it is stated that in some cases the house drains connect with the sewers, the assertion must not be taken as carrying with it the same signification as it would in an American city. The almost or quite, universal practice in Havana as regards the closet, is to place it over a sink or cesspool called the "Pozo ciego." In those houses where water closets are used and connected with the sewer, the connection is made by simply running an overflow pipe from the cesspool to the sewer, by means of which the liquid products of the former are carried over to the latter, the solid matter remaining in the cesspool awaiting removal at long intervals. Many of these Pozos are merely large holes dug in the ground, without masonry lining. Many have never been emptied within the memory of the house occupants. It must be remembered that these cesspools are not located at a distance from the house, in a back yard. Owing to the method of building pursued in Havana, they are within the house itself, and frequently in the immediate vicinity of the kitchen. It can readily be imagined in what a frightful condition of filth-saturation the soil of the city has become; a condition aggravated rather than relieved by the abundant water supply which increases the volume of liquid waste to be disposed of.

As regards paving, we find that a large portion of the principal streets in the city proper are paved with granite blocks, but owing to bad materials, poor foundations and the lack of maintenance, the surface is very irregular and the joints and depressions are filled with dirt. There are also a number of macadamized streets; these are invariably in a bad condition. It may be broadly asserted that there is no stone to be found in the country suitable for first-class road metaling. Up to the time of the American occupation

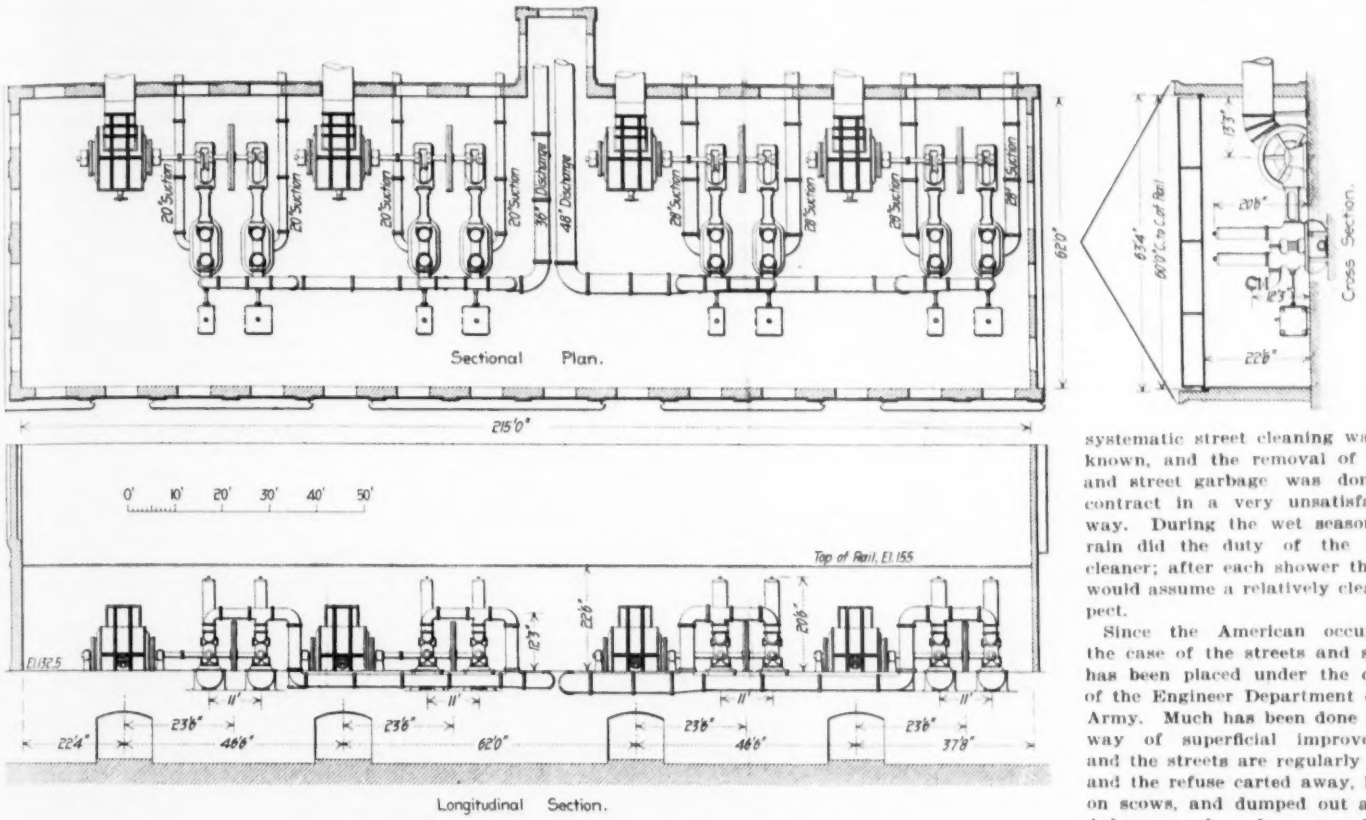


FIG. 7.—GENERAL ARRANGEMENT OF PUMP HOUSE.

systematic street cleaning was unknown, and the removal of house and street garbage was done by contract in a very unsatisfactory way. During the wet season, the rain did the duty of the street cleaner; after each shower the city would assume a relatively clean aspect.

Since the American occupation the case of the streets and sewers has been placed under the charge of the Engineer Department of the Army. Much has been done in the way of superficial improvement, and the streets are regularly swept and the refuse carted away, loaded on scows, and dumped out at sea. A large number of sewers—of those very imperfect ones already mentioned—have been opened and cleaned, giving them temporary relief, and in this way a great change for the better has been brought about in the external appearance of the city. Indeed, to the ordinary observer, Havana to-day would compare very favorably with many American cities, particularly in the South. No fundamental improvement has yet been effected, however, and the cost of this superficial work is very large in proportion to the results accomplished. The writer was informed last May, shortly before leaving Havana, by a high American authority, that at that time the work done by the Engineer Department was costing $300,000 a month, or an average of $10,000 per day. It must be remembered, however, that such work is always very expensive at the start, and it is to be supposed that as it becomes more systematized, a very great reduction of expense will ensue.

Undoubtedly the first step to be taken in the direction of permanent sanitary improvement is the establishment of a complete and efficient system of sewerage. The problems involved in the sewerage of Havana are by no means easy of solution. The chief difficulty is the final disposition to be made of the sewage. Different plans have been suggested, for a good deal of intelligent study has been already devoted to the question, each having its advantages and defects. The discharge of crude sewage into the almost stagnant bay is by all means to be avoided. On the other hand any system of sewage treatment by

means of which the purified effluent may be safely discharged into the bay presents many objectionable features. Disposal areas of considerable extent and of the right character of soil would be required and would be difficult to find, and furthermore, they would be exposed alternately to the festering heat and torrential rains of a tropical climate, both of which are detrimental to successful operation. Patented processes all more or less untried and therefore of doubtful value, have also been suggested.

It appears to the writer that it would be a very anomalous proceeding to adopt any system of

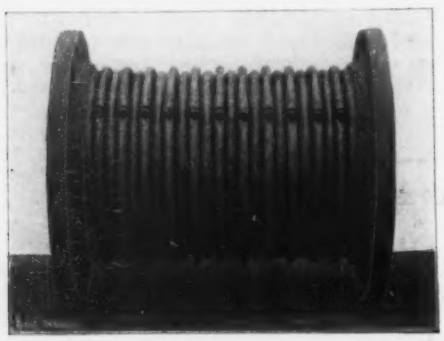


Fig. 1.—A 12-in. Corrugated Copper Expansion Joint.
Taunton Locomotive Mfg. Co., Taunton, Mass., Makers.

sewage disposal other than casting the refuse into the sea, in the case of a city situated directly upon the sea, and swept by deep and powerful ocean currents. Here again we are confronted with difficulties, however. It would be necessary to locate the outlet at such a point that there would be no danger of the sewage being carried back into the bay. Probably the best plan would be to drive a short tunnel under the easterly extremity of the narrow entrance to the harbor, where its width is less than a quarter of a mile, near the foot of O'Reilly St., for instance, through which the sewage would be forced by pumping to the Cabana side of the bay. From there it could flow by gravity through another tunnel, about two thirds of a mile long, driven through the Cabana hills, and discharged into the litoral current at a point between the Morro Castle and the mouth of the Cojimar River. This plan would probably be both the best and most expensive, and would solve the problem once for all.

No system of sewerage for Havana, or indeed any tropical city would be complete if it were not supplemented by storm-water drains for the relief of the streets in the rainy season. While it would be advantageous to admit a certain portion of the rainfall into the sewers for the purpose of thoroughly cleansing them, provision should be made for carrying away the greater portion by independent drains, having outlets to the sea between the entrance to the harbor and the suburb of Vedado.

It has been just said that the first sanitary requisite for Havana is a good sewerage system. The next requirement is a complete repaving of the city. Clearly it would be advantageous to carry out these two improvements simultaneously; that is to say when a street is opened for the building of a sewer, it would be well, if possible, immediately to repave it with the new material. It is doubtful, however, if this could be done, because a great deal of settlement would occur for a long time in the refilled trenches. This would seem to be particularly objectionable in the case of asphalt paving, which would otherwise on many accounts be the most desirable kind to use. It has been suggested that vitrified brick would be the best material for repaving the streets of Havana, having been used with great success and satisfaction in Jacksonville, Fla., and many other cities. This pavement could probably be put down immediately upon the refilled streets, because it could be readily brought up to a true surface should settlement occur to displace it. It could also at all times be easily taken up and replaced, when it became necessary to open the street for any purpose. Later, when all work in the street was finished, and no further settlement was to be apprehended, the brick would form an admirable foundation upon which to spread a sheet of asphalt.

Enough has been said to show that the problem of sanitation in Havana is by no means a simple one. It will be a gigantic enterprise to take in hand a city of some quarter of a million inhabitants, with narrow and crowded streets and design and execute a complete and adequate system of sewers and street improvements with a minimum degree of interruption of traffic and inconvenience and maximum economy. It is clearly a case where the highest special talent is required to prepare a carefully matured plan which shall best meet the peculiar conditions of the problem. The execution of the work should be entrusted only to contractors of known responsibility and experience, after competitive bidding, in order to ensure a faithful, rapid, workman-like and economical performance of the undertaking. It is not the slightest reflection upon the present Military Department of PublicWorks to say that from its composition and organization it is unsuited to deal with such an intricate and special case of purely civil engineering, still less to execute the same economically by day's labor under military direction. The result of the last six months' experience in the island of Cuba or at least in the city of Havana indicates, furthermore, that private enterprise will hesitate to enter the field as long as all departments are under military administration. There is no doubt that during the early days of American occupation a military rule was indispensable, but the interests of both Cuba and the United States will be best promoted by its cessation at the earliest possible date.

A NOVEL FORM OF CORRUGATED EXPANSION JOINT FOR STEAM PIPING.

The expansion joint for steam or other pipes illustrated in the accompanying cuts is a novel modification of the older form of plain, corrugated joint. Its general external appearance is quite well shown in Fig. 1, which illustrates a joint for 12-in. pipes. The details of its construction are, however, best shown in the sectional side elevation of Fig. 2.

As seen in the latter, the joint consists of two heavy flanges into which are secured the flanged ends of a corrugated tube of soft copper. The corrugations of this tube permit the end flanges to move toward or away from each other by bending the successive corrugations. To insure that the motion shall be equalized among the several

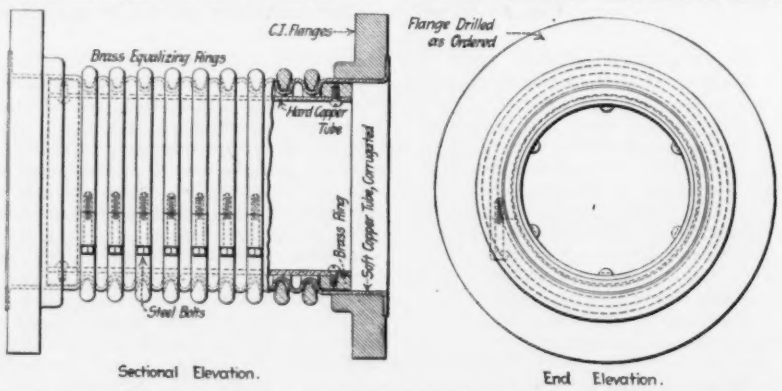


FIG. 2.—SIDE AND END ELEVATION OF THE WAINWRIGHT CORRUGATED EXPANSION JOINT.

corrugations, equalizing rings, as they are called, are placed in each corrugation, both outside and inside. These are of cast iron on the inside and also on the outside on large sizes of joints, and of brass on the outside in joints of moderate size. It will be seen that these rings insure that no corrugation shall close up beyond what the metal can stand without fatigue. An inner tube of hard copper aids in giving longitudinal stiffness to the structure, and as it is secured at one end only does not interfere with the free movement. In use, the joint is securely anchored at one end.

We are informed that in practical use, each corrugation is found to provide for at least 3-16-in. movement. Taking the rate of expansion of steam piping at .008-in. per 100 ft. of length per degree Fahr., and 300° as the range of temperature, it appears that one of these joints with 12 corrugations will safely take care of the expansion in a 100-ft. length of steam piping.

The joints are made for pipes rom 1½ to 16 ins. in diameter, varying in weight from 22 to 350 lbs., with a length, between faces, of from 12 to 30 ins. and a total movement of from 2 ins. in the small size to 2½ ins. in the large size.

Larger sizes are made for special work, and Mr. Wm. R. Billings, Treasurer of the Taunton Locomotive Mfg. Co., to whom we are indebted for the material from which this description has been prepared, states that the Metropolitan Ry., of New York city, already has six 30-in. joints for the exhaust piping of its new power station, and has recently placed an order for five more. These joints are said to be the largest ever made in this country. In their construction No. 32 seamless drawn copper tubing made by Randolph & Clowes was used.

THE BERLIN COMBINED TROLLEY AND CONDUIT ELECTRIC RAILWAY.

The city of Berlin, Germany, is now operating a mixed system of electric tramways; a portion of the line outside of the city being worked on the accumulator system, and both the trolley and the underground systems being employed on the portion within the city limits. Owing to this combination of systems it is necessary that each car should be equipped for taking the current from the overhead conductor or from the underground conductor, according to the portion of the tramway system being traversed. It is also necessary that this transition should be made as speedily as possible. Each car, therefore, has a trolley-pole and also an apparatus for taking the current from the conduit; and the latter, of course, can be lifted out of the slot when the trolley is in use.

For the conduit system, the two conductors, one of which is for the outgoing and the other for the incoming currents, are simple T-shapes, with the head vertical, and are set in the same horizontal plane. On the side away from the conduit the rail is of the ordinary type set in concrete. On the side of the track over the conduit the rail is made up of two similar rails, Fig. 1, between which is left a slot 30 mm., or 1⅛-in. wide. The exterior rail of these two alone supports the tire of the car-wheel, and the slot for taking the current also carries the wheel-flange.

The double rail rests upon cast-iron frames, located about 4 ft. apart, and is not supported between these frames. The rails are fastened to the frames by means of braced angles of forged iron, with four bolts, two in the base and two in the web of the rail. To prevent the closing of the slot by the crowding together of the two rails, the base of the rail is slightly inclined, in relation to the web, and it rests upon a bracket cast in the frame. The frames, with their two arms, enclose an ovoid space, 1.12 ft. wide and 1.48 ft. high, interior measurements. These frame are set in concrete, and form parts of a concrete conduit which encloses the current conductors. All water coming in through the slot is carried to the city sewers by means of channels spaced 164 ft. apart. The conduit is cleaned by a kind of scraper having about

the same section as the conduit. The Berlin authorities claim that the placing of the conduit under one rail results in a greater economy in iron and ultimate cost than if this conduit were in the middle of the track, as is the practice in America.

The Budapest conductors are each made of an angle-iron having a section of 100 sq. mm. The length of each section of the conductor is 32.8 ft., and the connection of the successive sections are so made as to avoid as much as possible any serious resistance at the joint. The section of the Berlin conductors is almost the same; but a simple T-form has been adopted, and the two heads of the tee are 4¾ ins. apart. The conductors are completely protected by the rails, so that it is impossible either to see or touch them through the

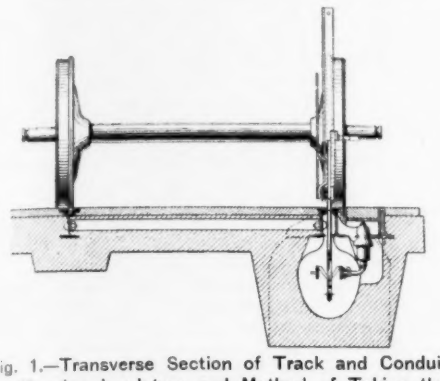


Fig. 1.—Transverse Section of Track and Conduit Showing Insulators and Method of Taking the Current, Berlin Electric Railways.

slot. As they are placed about 9½ ins. above the bottom of the conduit, they cannot be interfered with by water running in this conduit. The conductors are held by means of insulators attached to the web of the rails between the frames, and these attachments are spaced from 8.2 to 13.12 ft. apart.

The insulator is fixed in a socket bolted to the web of the rail by means of an intermediate bracket. In the inner part of the insulator is screwed a stem, bent at a right angle, and ending in a fork which holds the horizontal member of the T-iron, and is pinned to it. By this arrangement each insulator is protected from any drops of rain which might fall through the slot. The insulators are placed in cavities worked in the sides of the concrete conduit and are enclosed in cast-iron boxes; and each box is covered by a removable lid, so that access is easy for replacing the insulators.

In the conduit sections of the line the installation of the switches presented serious difficulties; but the system actually adopted in Berlin is practically the same as that used on American lines of a similar type.

The "plow," or apparatus for transferring current from the conductors to the motor, is made in two distinct parts, Fig. 2, one taking the positive and the other the negative currents from the conduit. Each part is essentially made up of a body of wrought iron, into which is fixed a well-insulated plate of copper, ending at the bottom in a sort of stirrup. A bronze tongue, moving around a horizontal axis, and controlled by two spiral springs, slides against the conductor. The springs tend to hold this tongue in a horizontal position, and it can slide either on the upper or the lower edge of the head of the tee. By its arrangement the plow can be easily placed in the slot, or as easily removed from it, when change is made from the conduit to the trolley system. With the tongue in contact, the current passes from the conductor to the copper plate, and thence, by an insulated cable, to the motors.

The plow is provided with four guide rollers, running in two vertical guides attached to the truck of the car. On the platform of the car is a ratchet-wheel working a chain, and by this the plow can be lifted or lowered as desired. On the lower end of the plow are two rollers which are used in entering or leaving a conduit section of the line, the ends of the lines being provided with inclined planes for this purpose.

The electric installation here described serves a very crowded district. The Budapest conduit system transported 20 millions of passengers in 1896. At Berlin, the Behrenstrasse-Treptow line is only 2¼ miles long, but it has carried not less than 12,000,000 of passengers. This represents, by day and in round numbers, a mean of 3,410 car-miles and 33,000 passengers. The cost of installation was about $24,200 a mile for single track, and twice that for double track. In this cost is included the complete installation of the conduit in beton, with the cast-iron frames and conductors, etc. The rails are not included. We are indebted to a recent number of "Le Genie Civil" for the information from which this description has been prepared.

THE EXPORTS OF MANUFACTURES of the United States during the fiscal year just ended show a remarkable growth, that of the manufactures of iron and steel being the most striking. The total increase in exports of manufactures during the year, as shown by the figures of the Bureau of Statistics of the U. S. Treasury, is in round numbers $48,000,000, and of this increase $33,000,000 is in manufactures of iron and steel. The total exports of iron and steel and manufactures thereof in the fiscal year 1899 were $93,715,951, against $70,606,885 in 1898, $57,497,872 in 1897, $41,160,877 in 1896, $32,000,989 in 1895 and $29,220,264 in 1894. On the other hand, the imports of manufactures of iron and steel continue to fall, having been during the year but $12,098,239, against $25,338,103 in 1896 and $53,544,372 in 1891. Thus, while the exports of iron and steel have been steadily growing, the imports have fallen, so that they are now about one-fifth what they were in 1891. All the classes of manufactures of iron and steel have shared in the growth of popularity abroad, but this is especially marked in the higher grades of manufactures, such as steel rails, locomotives, builders' hardware, machinery of all sorts, and especially those used in manufacturing. The number of locomotives exported during the year was 517, against 468 in 1898, 338 in 1897, 261 in 1896, 252 in 1895 and 142 in 1894, while the value of the exports in locomotives in 1899 was $4,728,748, against $1,028,236 in 1894.

THE RUSSIAN RAILWAY SYSTEM is rapidly increasing. According to statistics recently published at the instance of the Finance Ministry, there are at present open to traffic 26,750 miles of railway in Russia, and in course of construction or decided to be built no less than 7,400 miles of railway. Of these about half will be built as State railways, while the rest will be constructed by private companies. According to the present calculations, at least, the bulk of these lines will be ready in a couple of years' time, making an aggregate of over 34,000 miles, in addition to which new projects are continually coming to the front. The traffic of the Russian railways shows a rapid increase. In 1886 the total number of passengers carried amounted to 37,885,000 persons, which figure ten years later had risen to 655,000,000 persons.

A MOTOR CARRIAGE RUN between Paris and St. Malo, France, 226 miles, was made in 7 hrs. 35 mins. on July 30, according to press dispatches from Paris. Two vehicles made the run. The Paris-St. Malo express train is said to make the same run in 7 hrs. 48 mins.

THE SPANISH TRADE WITH CUBA, Porto Rico and the Philippine Islands amounted to about $40,000,000 per annum. About 75% of this amount was in manufactured goods, and considerably more than half of this trade was with Cuba alone. According to a statement of the British Consul at Barcelona, the exports of Spain to Cuba in 1896 amounted to $26,892,335; to Porto Rico, $7,532,162, and to the Philippines, $7,671,551, making a total of $42,096,048. The goods exported may be classified as follows:

	Man. goods.	Provisions.	Raw matls.
Cuba	$16,530,420	$10,170,110	$191,805
Porto Rico	5,821,595	1,680,300	30,264
Phil. Ids.	6,850,178	814,110	7,262

THE LARGEST INCREASE IN IMPORTATIONS into the United States during the fiscal year just ended is in articles required for manufacturing, and food stuffs not produced in this country. A statement prepared by the Bureau of Statistics, U. S. Treasury Department, covering all articles or classes of articles in which the importation increased or decreased as much as $1,000,000 during the year, shows an increase in nearly all articles of foreign production required by our manufacturers. Unmanufactured fibers, raw silk, crude rubber, bar and block tin, hides and skins, undressed furs, cabinet and other woods, unmanufactured tobacco, and chemicals for use in manufacturing, all show a heavy increase, wool being the only important item of material for the factory which shows a reduction in imports. In the above classes the increase amounts to about $30,000,000, though the reduction of several million dollars in wool brings the net increase in manufacturers' materials to something less than that figure. In food stuffs, the principal increase is in sugar, tropical fruits, and cacao, the increase in these being above $30,000,000. The very heavy importations of sugar just prior to the enactment of the tariff law of 1897 made the sugar importations of 1898 extremely light, so that those of 1899 show an increase of 50% in quantity over those of 1898, but many million pounds less than those of 1897.

THE HOLLAND SUBMARINE BOAT was recently tested by representatives of the Navy Department, with a view to comparing the advantages of steam and gasoline engines for furnishing the propelling power. The Department proposes to use steam, but the inventor is in favor of gasoline, on account of the rapidity with which it enables the boat to be got under way.

WIRELESS TORPEDOES whose direction is controlled by electric waves, such as are utilized in the wireless telegraph system, are said to have been invented by Walter Jamieson and John Trotter, of England. Two rods which project above the water serve as receivers for the electric waves, and are connected with the steering gear. The course of the torpedo is watched, and electric waves generated by apparatus on the torpedo boat are discharged as required to affect one or other of the receiving rods.

CHANGES IN THE ARMOR of the new battleship "Maine" have been decided upon by the Naval Board of Construction, on the recommendation of Rear Admiral Hichborn, Chief Constructor. The bidders proposed to reduce the weight of armor by 200 tons, in order to avoid increasing the draft on the stipulated displacement. The Board holds that the displacement must be not less than 12,500 tons, with 2,000 tons of coal in the bunkers, and on a draft of not more than 23 ft. 10½ ins. The same total weight of armor will be retained, 2,500 tons, but the thickness of the belt amidships will be reduced from 12 to 11 inches, additional protection being then given to the parts beyond the belt. The "Maine" is now under construction at the yards of the Cramp Ship & Engine Building Co., and similar changes will be made in the plans of the sister ships, "Ohio" and "Missouri," which will be built by the Union Iron Works, San Francisco, Cal., and the Newport News Shipbuilding Co., of Newport News, Va.

A PENNSYLVANIA R. R. PENSION AND SUPERANnuation fund is being created for the benefit of employees of that company. It is understood that 70 years of age has been fixed upon as the age for compulsory retirement; and any employee having served 30 years, but not having reached the prescribed age, will be entitled to the bene-

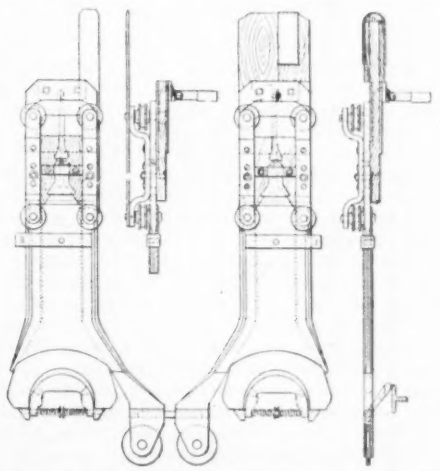


Fig. 2.—Plow, or Apparatus, for Conveying the Current from the Conductors to the Motors, Berlin Electric Railways.

fits of the fund upon the approval of the committee having the fund in charge. The pension allowance is not stated, but will depend on length of service and average wages received during this service. Definite action fixing the rates and methods of payment will be taken at the fall meeting of the stockholders, and the system will then be put into operation. It is estimated that it will require an annual expenditure of about $300,000 by the company to make the fund effective. This fund will not interfere with the existing employees' relief fund, but will work in entire harmony with it.

ELECTRICAL SUBWAYS IN SAN FRANCISCO seem to be assured in the near future, due largely to the work of the Marchants' Association and the co-operation of the telegraph, telephone and electric light companies. Seven of these companies have agreed to carry out an ordinance drawn by the Merchants' Association, providing for the burial of their wires. The ordinance has been approved by the street committee of the Board of Supervisors and it is expected that it will be passed by the full board.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, - - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, - - - TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, } ASSOCIATE EDITORS.

A. B. GILBERT, - - - - - - - ASSISTANT MANAGER.

CHAS. W. REINHARDT, - - - - - CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York,
M. C. ROBBINS, Chicago,
S. B. READ, Boston,
C. F. WALKER, Cleveland,
} ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 299 DEVONSHIRE ST.
CLEVELAND OFFICE, OSBORN BUILDING.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

In ordering changes of mailing addresses, state BOTH old and new addresses; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 329 means that subscription is paid to the 32d week (that is the issue of Aug. 10) of the year 1899; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXII. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

A great many people are exercising themselves in these summer days over the question of a proper name to apply to vehicles for use on common roads, propelled by some form of mechanical motor, and names without limit have been proposed. It is apparently supposed by these industrious word coiners that all that is necessary is to invent some word of pleasing sound and correct derivation in order to have it adopted by general consent to designate this new class of machines. As a matter of fact, however, language is not made in this way. It is an easy task to coin a word; but the powers of an autocratic sovereign could hardly give to it that current usage which makes it an integral part of the language.

Some four years ago the terms "horseless" and "moto" were much used as prefixes to designate vehicles driven by mechanical motors. These have now almost disappeared, and the French term "automobile" has come into extensive use; while the prefix "auto" threatens us with such terms as "auto-trucks," and "auto-cabs." We seriously doubt, however, whether these words are here to stay. In our issue of Dec. 12, 1895, we pointed out that instead of some new word gaining currency, the language was likely to grow in the natural way, and the term "motor-vehicle" was likely to come into use just as the old terms "ox-cart," "pony-carriage," "express-wagon," etc., had in the past. We also noted that the prefix motor was applicable to any sort of vehicle propelled by a mechanical motor, so that such terms as "motor-truck," "motor-carriage," "motor-cycle," etc., would be naturally adopted. Should it be desired to distinguish a particular form of motors, its name will naturally take the place of the word "motor," so that we will speak of the "electric cab," "steam wagon," "gasoline carriage," etc. The driver of any of these vehicles is likely to remain the "driver," except on large vehicles for public use, where he may be a "motor-man," as on an electric car.

As evidence of the trend of usage at the present time we have looked over recent issues of a journal established some four years ago, when "horseless vehicle" was gaining much currency, and which chose for its name "The Horseless Age." Its front cover announces that is is published "in the interest of the motor-vehicle industry." It contains seven advertisements of firms who offer machinery and supplies for the manufacture of "motor-vehicles" or "motor-carriages," and two who offer the same thing for the manufacture of "automobiles." One manufacturer offers "automobiles" for sale, while seven offer "motor-vehicles" or "motor carriages." One "Automobile Company" offers "electric vehicles" of a dozen different styles, and calls them "electric cabs," "electric surreys," etc. "The Automobile Co. of America" offers "horseless carriages" and "motor vehicles."

In view of this showing, our choice of the term "motor-vehicle," etc., as our standard for designating this new class of machines, seems thoroughly justified. This matter is one of considerable practical importance in the indexing of engineering literature, and we think those in charge of the editing and indexing of engineering society publications, and the classification of engineering libraries will make no mistake if they follow our practice in this matter.

A long struggle over water rates at Chattanooga, Tenn., seems to be drawing to a sensible conclusion. The works are owned by the American Water-Works & Guarantee Co., of Pittsburg, under the local name of the City Water Co. For some time past there has been an attempt on the part of the city to secure lower rates. An agreement has at last been drawn up, which it is understood will be signed by both parties, submitting the domestic rates to arbitration by a committee of three engineers. The cost of constructing and operating the works, and other pertinent matters, are to be taken into account. The agreement seems a little one-sided at first, through a provision that while the present rates may be lowered, they shall not be increased, even if the arbitrators decide that it would be only fair to the company if they were higher. Doubtless the company knows where it stands, and is willing enough to continue the old rates. Besides, the agreement provides that the rates once fixed shall stand for 20 years. On the other hand, the city is to have the right, which it seems it does not now possess, to buy the works at an appraised valuation at the end of each five-year period of the contract. The new contract is also commendable in that it is unusually definite in stipulating just what public services are to be rendered by the company for the $7,000 a year which the city is to pay throughout the contract. It is significant that this yearly payment is less than has been paid previously, notwithstanding an apparent material increase in the services to be rendered. To anyone who has studied the table of water rates charged in 1,250 cities, as given in "The Manual of American Water-Works" for 1897, and observed both there and elsewhere, the wide variations in rates and methods of assessing them that prevail throughout the country, it is apparent that both city and company at Chattanooga are doing well to settle their differences on the basis of cost of service, rather than by insistence, on either side, that the rates should not exceed the average of those charged in a number of other cities, under dissimilar conditions.

This bids fair to be a record year in court decisions relating to water pollution. The Paterson and Newark cases, holding that the discharge of sewage into the Passaic River constituted a nuisance, were handed down some time ago. Since then an important Arkansas case, decided in the Federal court, has been reported, while on July 30, Judge Orlady, of the Supreme Court of Pennsylvania, did the cause of sanitation and law good service by a strong decision affecting the water supply of York, Pa. The main facts in this case are given in a note elsewhere in this issue. The evidence showed that the sewage wastes from a house were discharging into a stream used, lower down, as a public water supply. The Judge used the following language in his decision, which may well be a source of encouragement to all who are fighting for the purity of public water supplies and the preservation of the public health:

> No prescription or usage can justify the pollution of a stream by the discharge of sewage in such a manner as to be injurious to the public health. Lapse of time will not legalize a public nuisance. To deposit in a natural water course, in close proximity to a source of supply from which the water is used for domestic purposes, the noisome and offensive matter described in the uncontradicted evidence in this case is a public nuisance, and it should have been so declared by the court.
>
> The Commonwealth cannot be expected to prove to an absolute certainty that disease-producing germs are carried a given distance in a water course, as it would be an exaction impossible of performance to require a chemical and microscopic analysis of the whole body of a stream of water. Such a fact is not capable of being demonstrated to a mathematical certainty, and such a degree of proof is not demanded by the law. Whether a state of facts amounts to a nuisance is in many cases dependent on the opinion of witnesses, and a reasonable and probable exactness, based on experience and scientific investigation, is the most that can be expected in such cases.

It is thought that this decision will be of material assistance to Philadelphia and other communities in Pennsylvania that are seeking to restrain individuals from polluting their water supplies.

The movement for so-called free water at Detroit has received a set-back in the nature of a court decision declaring unconstitutional the act providing for a partial abolition of water rates, reviewed editorially in our issue of June 29. The decision was not based on the inequitableness of the proposed plan for distributing the expenses due to water-works among those benefited, but on the fundamental principle that the people alone, or else representatives chosen by them for that purpose, have a right to say what sums shall be raised for taxation. This principle, in the opinion of the lower court, being violated, there was no occasion for considering whether the plan proposed was fair or unfair. We pointed out in our issue of June 29 that the division of expense between water users, taxpayers and owners of land fronting on streets in which new mains are laid seemed to be quite arbitrary, even if it should be agreed that supplying water for certain domestic and sanitary purposes free of charge was justified on broad general grounds of promoting and protecting the public health. To make our meaning more clear, we may re-state what we have previously said in discussing the general subject of raising money to meet the expense of providing sewerage and water-works facilities. All such works yield two great classes of benefits, public and private. The public benefits of water-works, for instance, are those coming from fire protection, water for street sprinkling, sewer flushing and public buildings, and the corresponding expenses should be met by general taxation. The private benefits are, first, the increase in the value of real estate due to the fact that a public water supply is available, reflected in the immediate increase in the value of city lots on the laying of water mains in front of them, and, second, the benefit of the actual use of water. The Detroit scheme recognizes each of these benefits, but in distributing the water-works burden among them seems to follow convenience rather than any scientific principle, as will be seen from the following: The operating expenses due to water furnished for certain domestic, sanitary and charitable purposes, and for public uses in general, go into the tax levy, as do the charges for interest and sinking fund on account of the remaining water debt, and all construction except new 6-in. mains, or their equivalent cost, where larger ones are laid. The cost of 6-in. mains is the only charge made upon abutting property, or assessment for benefit. The charges for benefits of use fall on users, except the classes already named as exempt, but these charges are based on operating expenses alone. If such a plan as this results in a proper distribution of the water-works burden among the classes benefited, it will be more by good luck than careful apportionment. The first step to be taken, if an apportionment by benefits were to be made, would be to ascertain the capital charges on account of building works

Fig. 3.
Plan of Culvert
to Carry Head Race
Beneath Morris Canal.

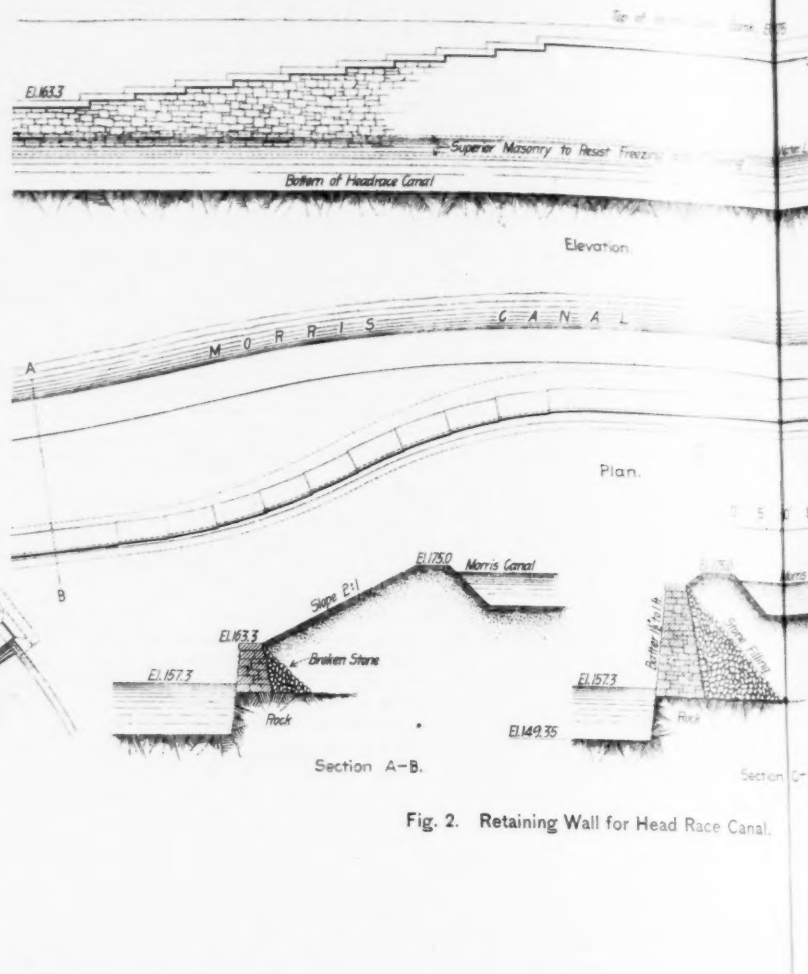


Fig. 2. Retaining Wall for Head Race Canal.

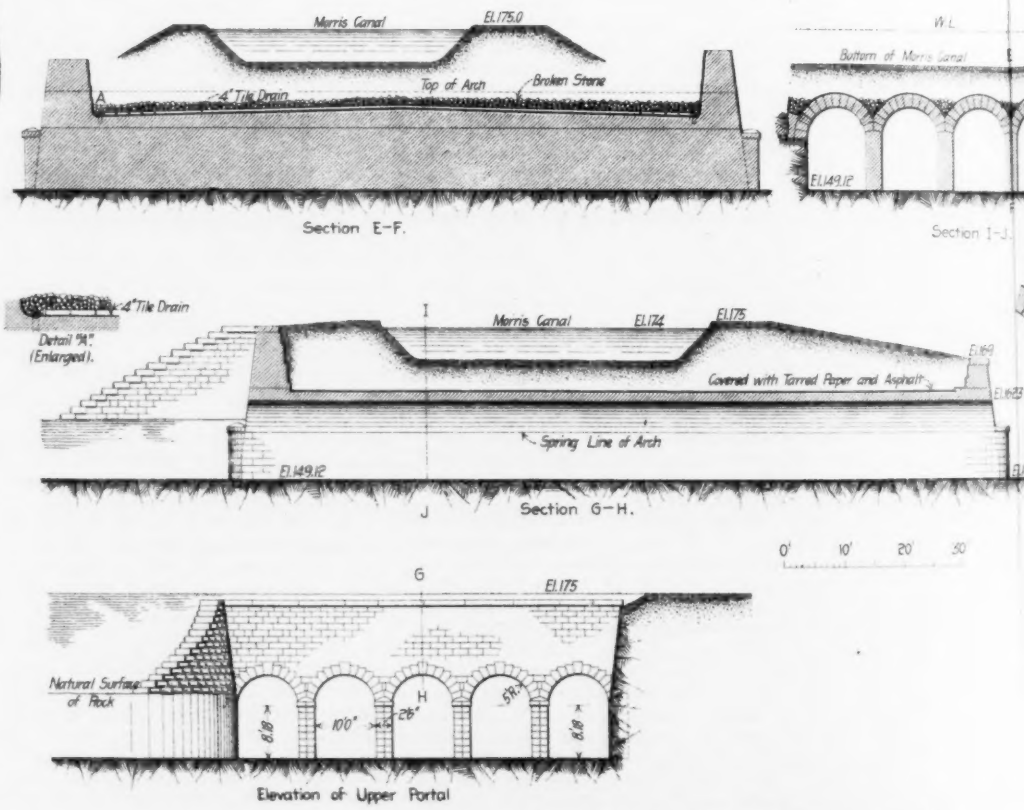


Fig. 4. Elevation and Sections of Culvert to Carry Head Race Beneath Morris Canal.

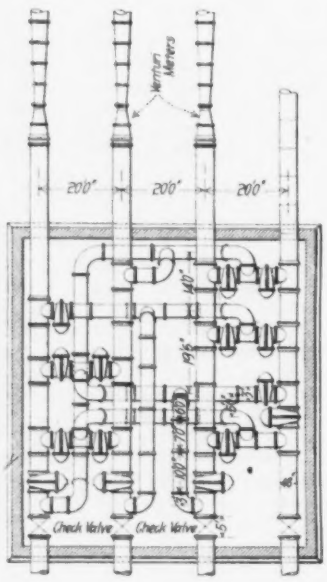


Fig. 9. Hydraulic
Switch Board
for 48in. Pipes.

THE POWER DEVELOPMENT AND PUMPING STATION OF TH

Clemens Herschel, M.Am. Soc. C. E., M. Inst., C. E., Chief Engineer.

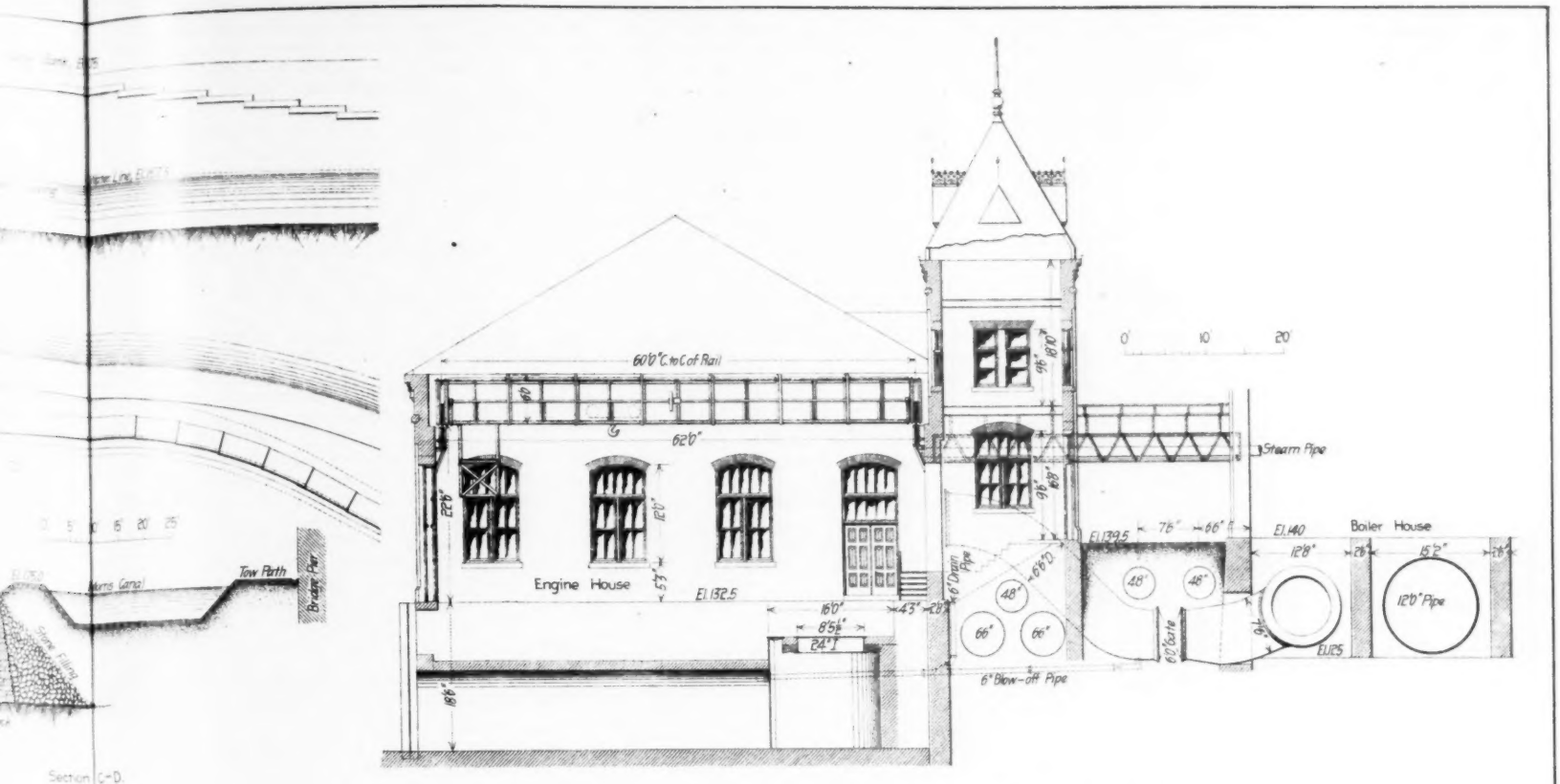


Fig. 8. Section through the Power House on Line X-Y.

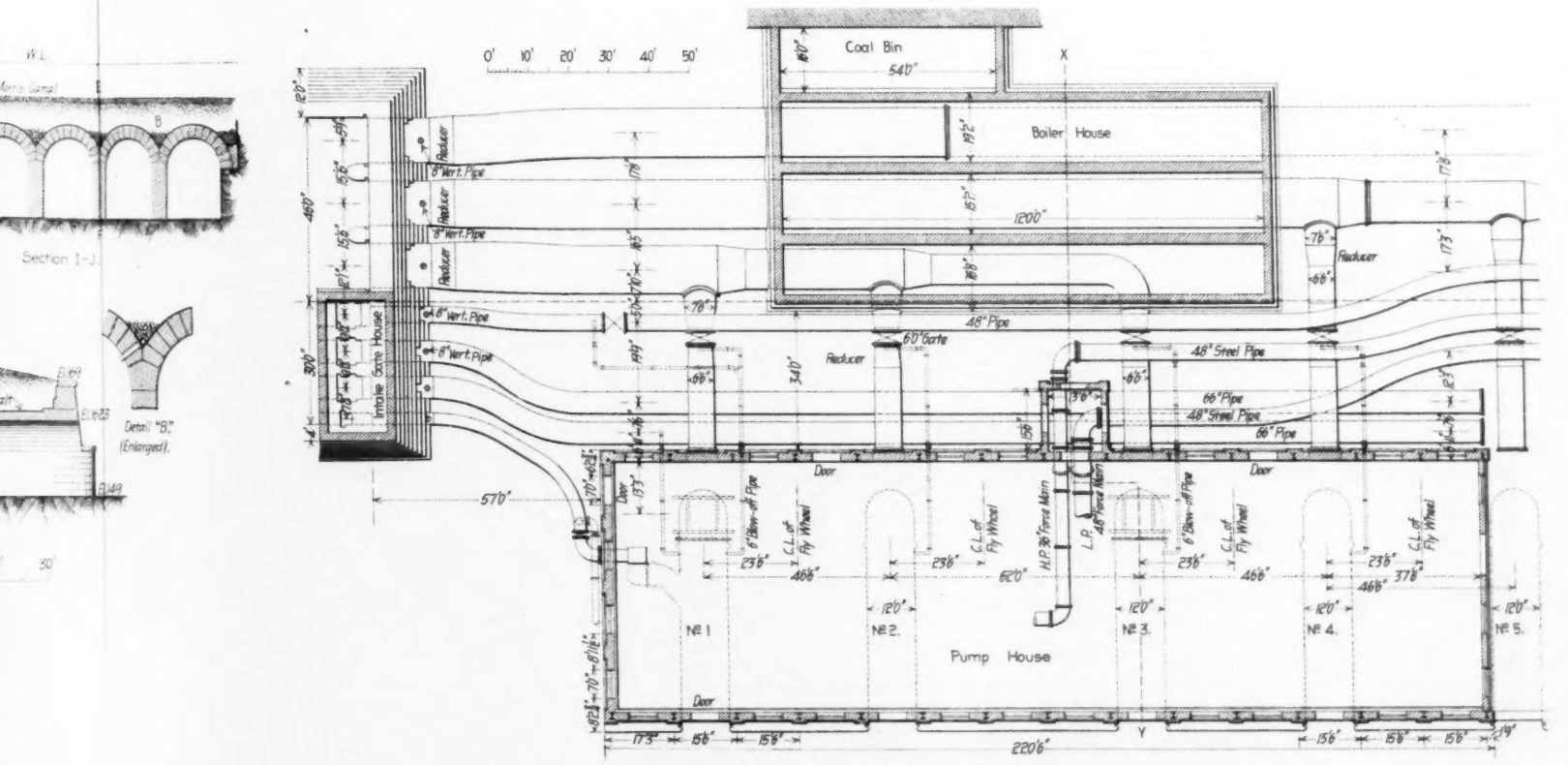


Fig. 6. General Plan of Power House and Piping.

Canal.

TION OF THE EAST JERSEY WATER CO., AT LITTLE FALLS, N. J.

T. A. Gillespie Co. and Dickson Mfg. Co., Contractors.

CHAS. HART, LITH., 86 VESEY ST., N. Y.

adequate for fire protection and other public purposes. To this sum should be added further capital charges on account of all classes of fixtures exempt from rates on grounds of public policy, such as religious and philanthropic institutions and domestic and other private services rendered free on the score of public health or otherwise. The result would give the capital charges to be inserted in the general tax levy, which sum would be further increased by the corresponding operating expenses. The balance of the capital charges and operating expenses would then fall on private water consumers not already exempted and on real estate especially benefited. Assessments for benefits could be made in the case of extensions to the mains, diminishing capital charges accordingly; or it might be held, in the case of long-established works, that since the bulk of real estate in the city had paid no special or betterment assessments the plan should not be adopted.

If the agitation for free water at Detroit utterly fails in its specific purpose, it seems more than probable that the city will be far better off than if it succeeds. It is to be hoped that out of all the public attention centered on the subject of water rates some good may come. This will certainly be the case if there finally results a more equitable division of the charges between the city and private consumers.

WHAT HAD BEST BE DONE WITH THE NEW YORK STATE CANALS? A SYMPOSIUM.

In our issue of May 11 we published the circular letter of inquiry which the expert commission appointed by Governor Roosevelt of New York sent out on May 1, asking for facts and opinions on the question: What had best be done with the New York State Canals? This letter, as will be remembered, suggested five possible solutions of the problem, and those who received it were asked to state their choice between these solutions, and to give the reasons for their preference. The solutions which were suggested were as follows: (1) To complete the present project of enlarging the Erie, Oswego and Champlain canals at a further cost of $15,000,000 or $24,000,000 in all; (2) to enlarge the present locks on the Erie Canal to a length of 260 ft., a width of 26 ft., and a depth of 11 ft., making them suitable for boats 25 ft. wide, 125 ft. long and 10 ft. draft. This work was estimated to cost about $6,000,000; (3) to construct a barge canal continually descending all the way to the Hudson River from Lake Erie, with a depth of 12 ft., and suitable for barges of 1,200 tons to 1,500 tons, which can be towed on the lakes if desired. The cost of carrying out this project was estimated at $50,000,000; (4) to construct a ship canal with a depth of 20 ft. to 30 ft., suitable for lake and ocean vessels of 5,000 tons to 10,000 tons capacity at an estimated cost of $200,000,000 to $500,000,000; and (5) to abandon the canals entirely and dispose of the property interests therein on the best terms which can be secured.

At the time the commission's letter of inquiry was published, we commented upon it at some length, and as most of our readers will recall, we have at one time or another during the past two years discussed nearly, if not quite all, of the various solutions of the problem suggested by the commission. We shall not continue these discussions now, but as the commission's inquiry has been favored by a considerable number of replies from prominent engineers, vessel men, and shippers, we have thought it of interest to summarize the gist of these replies at this time. This we are able to do from the printed report of the correspondence, which has just been published by the commission, and which is in some respects one of the most interesting documents which has appeared in all the voluminous discussion of the various questions that have arisen in connection with the recent canal improvement projects in New York. The volume of this correspondence is altogether too great to permit of its being published in full.

The report gives in all 56 replies to the commission's circular. A few of these replies are not of much value, but as a rule they furnish information which is at least of general interest even when they fail to answer definitely the questions asked by the commission. It is interesting to note that only one writer advocates outright the abandonment and sale of the canals by the state, although several express considerable doubt about any further expenditure for improvements being justified under the present circumstances. It is further quite generally agreed by the various writers that the state canals as they now stand are out of date as transportation lines, and that they are becoming of less commercial value each year. Summarizing the replies numerically as well as it is possible to do, eight advocate the completion of the present project, 13 favor the second project to enlarge the locks, 16 suggest the construction of a barge canal as the best solution of the problem, and six or eight advocate the construction of a ship canal, but differ considerably in their ideas of the best route for such a large waterway. The other replies are general dscussions favoring more or less strongly the maintenance and improvement of the canals by the state or United States governments, but not committing the writers to any particular plan of improvement.

(1) Taking up in detail the various arguments presented for and against each of the proposed plans, we have first the proposition to complete the present project. It is reasoned in favor of this plan as follows: Whatever is to be done toward improving the canals should be done quickly, and the present project permits of the earliest completion of any of the plans proposed. The interests to be conserved by state canals should be primarily state interests; cheap transportation for the farmers in the western portion of the state, developing industry and creating employment along the banks of the canal, and maintaining the commerce of Buffalo and New York, which results from the trans-shipment of goods at those cities. These interests would be injured rather than benefited by a ship canal, and the same would be true in a less degree of a barge canal. The present deepening is the utmost change that can be accomplished on the present routes. Greater enlargement is prohibited by the present large aqueducts, by reason of land damages, the enormous spoil banks, the interference with other traffic, and by the large bridges and ferriages that would be required. Any other plan also means the practical throwing away of what has already been done, while by the continuation of the present project advantage may be obtained from the $9,000,000 which has been expended.

The present improvement will make the Erie Canal suitable for boats of 8 ft. draft. According to the report of Major Thomas W. Symons, the cost of transportation by a barge canal would be 3.67 cts. per bushel from Buffalo to New York, and by the 9-ft. canal, 4.36 cts., a difference of 0.69 ct. The charge against the barge canal would be 1¼ cts., and that against the improved canal 0.49 ct. per bushel, a difference in favor of the 9-ft. canal of 0.76 ct. in the investment, against a possible saving in transportation by the barge canal of 0.69 ct. In view of the probable tonnage being doubtful, and that the whole cost of transportation by barge canal, even when based on the assumed tonnage, is not shown by the estimates to be lower than by the improved canal now under construction, it would seem the wiser policy for the state and people not to go beyond the plan already adopted. By continuing the present project the people will save what they have already invested, and render the canals as useful and economical as any canal can be on this line under the controlling conditions.

The reasons urged against the completion of the present project are not so briefly stated. If this project is carried out we shall be as far behind the times in the way of cheap transportation in a few years as we are now. The anticipated reduction in the cost per bushel to follow from the small deepening projected will not turn out to be correct, as this reduction is based on theory, and the conditions of practice will modify the results. While the improvement would be of value, it would not be a final solution of the question. The commerce of the West is too vast to be accommodated by it, and the present diversion to the South and Southeast would continue. The plan proposes not only the retardation and increased cost of transportation inseparable from small channels of communication, but adds the cost of one or more transfers between the producers and either the consumers or advancers in value of the freight carried. No canal of the type proposed can compete with the railway, which can and probably will do the work more cheaply. This conclusion rests on two facts. One of these is the steady, continuous, and not yet ended improvements in methods of railway transportation which have lowered operating expenses to a point not dreamed of as possible a generation ago, and doubtless will lower them even more in the future. The other is the nature of railway operations which brings it about that the railway can, with profit to itself and with advantage to the community, carry low-grade traffic at a comparatively small excess over operating expenses. The passenger traffic and higher class freight traffic can contribute more fully than the low class freight toward fixed expenses, and enable the latter, especially when offered in large volumes, to be carried at least as cheaply as the canal can carry it. When completed, the size of the boats which can be used would not be sufficient to hold the trade in competition with other routes, rail and water, which have so largely increased their carrying capacity. A partial enlargement would probably result, a few years hence, in having the work done over again, and the total expenditures would be a larger sum than would now be required to build such a canal as the interests of the state demand. Grain, if carried at all through the state, must be carried at a rate much less than it is possible to carry it on a canal of the dimensions proposed. Any plan of improvement which does not offer on its completion a freight rate on cereals sensibly less than 1 mill per ton-mile should not be considered for the Erie Canal. To deepen the canal without enlarging the locks is folly.

(2) In favor of the second plan proposed it is argued that it is impossible for the canal to hold the commerce with the present sized boats, as the prices for carrying grain and other freight must be largely reduced in order to retain the business, which can only be accomplished by the use of much larger boats. To enlarge the locks will at once make it possible to build a new fleet. This plan would double the capacity of the boats without deepening the canal, and at a small outlay as compared with the first plan. Something must be done to encourage the building of new boats. Owing to the fact that the enlargement of the locks of the canal has been in anticipation for several years, practically no boats have been built nor will there be until this question is settled and the work undertaken. With the locks enlarged the question of increasing the size and deepening the prism could be considered later, during which time new boats would be built of the larger size, suitable for 8-ft. or 9-ft. draft; and could be operated successfully with the present depth of water by cleaning out the canal and straightening a few short bends. The capacity of the boats could be nearly doubled at once.

The principal argument against the second plan is that to enlarge the lock without at the same time enlarging the canal prism would result in no benefit. The present legal width of the prism is 52 ft. on the bottom and 70 ft. on the surface. With these dimensions the canal is not adapted to navigation by boats of any considerable width greater than the 17 ft. the boats used now have. It would be several years before new boats would be built to take the place of the present boats even if it were possible for the larger boats to navigate the old channel. The estimated cost of $6,000,000 is inadequate for the work.

(3) The number favoring the construction of a barge canal is greater than that in favor of any of the alternative plans. Among the chief reasons urged in favor of this plan is the one that the tendency of modern transportation has been towards a reduction in the cost of transportation coupled with an increase in the size of the carrier. Therefore, to place the canal in a position where it can meet the modern demands of transportation it should be transformed into a barge canal, capable of carrying barges of 1,200 to 1,500 tons

capacity. The canal that is to be permanently useful in the future must be a waterway that can be entered and navigated by the barges that may be used in the natural water courses connected by the canal. Rates by rail have reached such a low point that the possibility of trans-shipment from lake or river craft to canal boats is very much restricted. The system of barge transportation is not new and untried, but has grown and been developed along the Atlantic coast until for certain kinds of merchandise it has largely superseded other methods of transportation. Some steam colliers have even had their machinery taken out and been converted into barges for towing, and the advantages of barges that can go anywhere on the lakes and anywhere in the harbors along the coast to discharge their freight, either upon wharves or directly into vessels lying at wharves, are such as belong to no other class of vessels. If cargoes of grain can be brought from lake ports direct to New York, and when there if they can be transferred, without any expense for handling or terminal charges, either at Buffalo or New York, direct to ocean steamers lying alongside, then the cost of freight between places of production and consumption will naturally be reduced to a minimum.

A frequent argument used against the barge canal idea is that it is entirely improbable that the people of the state will favor so extensive a plan and vote the money necessary for carrying it out. The present prism is not adapted to such improvement as would be necessary to turn it into a barge canal. Originally the canal was located with a view to a very small prism, and when enlarged it was not relocated, except at some places where bends were cut off. To-day there is constant danger of breaks at various places due to the location of the canal. Along the Mohawk the canal is hung up along the side of a bluff; practically the same condition exists near Rochester, and the difficulties of constructing a barge canal on the Jordan level and over the Montezuma marshes would be almost insuperable from a financial point of view. It is believed, however, that these difficulties could be overcome by a realinement of the canal, and perhaps by canalizing the Mohawk and other rivers. Past experience in the liberality of the state in making appropriations for canal improvements would mean at least 50 years' work before a barge canal could be run from New York to Buffalo, or points on the lakes. A delay of that kind would mean that what little inland water commerce the state of New York now enjoys would have died out. The estimated cost of $50,000,000 is too small. A more correct estimate is $100,000,000, which puts a far different face on the saving to be effected over the present canals.

(4) In favor of the ship canal plan it is argued that the railway companies, by their system of long hauls without transfer of cargoes, are enabled to compete sharply with medium-size lake vessels carrying 2,000 or 3,000 tons, but they do not disturb by competition vessels carrying 5,000 and 6,000 tons; the general expenses of the small ships being within a fraction as great as the expenses of the larger ships. It is criminal folly to leave all the lake cities absolutely without protection in the contingency of a war with England, and it would be criminal waste to spend in fortifying them as much as the canal would cost, which would protect one and all and would at the some time many times pay for itself in savings to the people. Canada is pushing all means for carrying its own freight and diverting ours to its transportation lines with unexampled energy. When the canal connecting the Georgian Bay with Lake Ontario is completed, New York may find her commerce diverted to the north, as it long has been to the south.

The arguments against the ship canal plan are more vigorously stated. There are only two available routes for a ship canal within the state, viz.: the Erie-Mohawk and the Erie-Ontario-Mohawk, the lengths of which from Buffalo to New York are, respectively, 495 miles and 483 miles, and the estimated costs of which are, respectively, $420,000,000 and $274,000,000. The probable tonnage by large vessels depends largely upon the difficulties of navigation. The possible speed of large vessels in a long narrow channel is greatly overestimated. On the Suez Canal seven miles an hour is not yet possible, and it has the advantage of a much larger section than would be possible in the proposed canal. Again the difficulty of taking large vessels through 10 or 15 locks daily, in all kinds of weather, would appal the most expert mariner. To take a 5,000 or 7,000-ton vessel through 350 miles of narrow channel, 150 ft. wide, around turns, and even on the straight stretches, in all weathers, at a speed of over four miles per hour, would tax the ability of the ablest pilot. There would be innumerable groundings and collisions, causing great delay. It would probably be found cheaper to tow the vessels through; and where would be the economy of steaming or towing a vessel at four miles per hour designed for a speed of 15 to 20 miles per hour. The machinery would be worked at immense loss, if the vessel steamed herself, and if she were towed it would take the room of paying tonnage.

The idea of a through route to Europe is visionary. Even the moderate-sized lake vessel would return through the canal nearly empty, for the westward tonnage is but a fraction of the eastward by any and all routes. The commerce of the lakes consists largely of local trade between lake ports in commodities which do not come from or go to the seaboard, and the vessels bringing down grain, ore, etc., return with full cargoes of coal, merchandise, manufactures, etc. They could not afford to lose this advantage by trading through the canal with New York. Tonnage from the seaboard is usually high-priced, and demands the quicker transportation and distributing facilities of railways. The vessels and crews of the lake service are especially adapted to its commerce and navigation. The vessels are not built, the crews are not trained, for the ocean. The lake vessels are not built so strong, and their machinery is not suitable for salt water; they are much cheaper. From these considerations it seems evident that neither ocean nor even lake vessels would be tempted to make a general use of the ship canal, and it would be occupied mostly by small steam vessels and barges and canal boats, which could readily navigate a canal half as large and vastly less costly. Finally there is the great handicap against the canal of five months closed navigation.

A liberal estimated tonnage would be 12,000,000 tons. The actual charge for investment, maintenance and operation would be about $12,200,000. This would wipe out any gain in rates as compared with the present canals. As a military necessity there is no call for the canal, as our shipping on the lakes is greater than that of Canada, and it would be a very mild enterprise for the enemy to blow up a structure or a bank somewhere in the 200 miles and trap our war ships en route. The cost of the construction of a ship canal is greater than the taxpayers of the state will be willing to assume, and it can be built only by the Federal Government.

(5) The arguments against abandoning the canals, as suggested in the fifth proposition, are pretty unanimous, as has already been stated. Some of the more vague ones are that, it is unpatriotic, a commercial calamity, an unworthy view of the great work done by the projectors of the state canal system, that much of the commercial supremecy of the state has been due to the canals, etc. The more concrete objections against abandonment are: That the canals act as a regulator of railway rates, and this benefit will be lost if they are abandoned. If abandoned the present tendency of traffic to seek Gulf ports and to go by Canadian water routes will be emphasized so as to endanger greatly the future commerce of the state and city of New York. Various European countries which have abandoned their canals have been forced to resume them and to build further waterways. Under easily attainable conditions the enormous and rapidly increasing commerce of the Great Lakes can be made tributary to New York, which is impossible if the canals are abandoned. To abandon the canals is to drive the Buffalo-New York route out of first place at once and to make it soon merely one of the routes contending for the lead in the race to the seaboard. Nothing but the water route will keep the railways between New York and Buffalo at their best.

In opposition to these claims it is urged that the often repeated assertion that the railways put up the rate of transportation when the lakes and canals necessarily suspend their business during the winter months, is not correct in fact, and that if the rates are usually raised about that time there are reasons for it much more important than the fact of the hibernation of the boats. If the conditions existing in Europe in reference to rail and water transportation be carefully compared they will be found to be entirely different from those existing between Buffalo and New York city. The rail rates in Europe can nowhere compare with the rail rates beween the Atlantic seaboard and Chicago. One physical reason for this is the size of the loads hauled, both in trainload and in unit, and in the power of the locomotives. We are now building cars in the United States that can carry from 60,000 to 100,000 lbs., while in Europe 20,000 lbs. is an unusually heavy load for a car.

An important consideration which bears upon this general question of the operating of any canal paralleled by first-class railways in the United States, especially those moving freight eastward, is the radical change that has taken place within the last ten years in the method of forwarding grain and other commodities from our great interior country to the markets of the world; that is by through bills of lading from the points of production, no matter how small these centers of production may be, even small towns, direct to Liverpool, Havre, Bremen and other European ports of consumption. This is done by agents of European houses located all over our western country. The same rule applies to cotton and other such productions, so that the route by which the export freight goes, whether by rail or water, or, whether it goes by the Atlantic or Gulf seaboard, is not such an important question as it was formerly. Another important factor which has much to do with lowering the rates outside of any possible influence of the Erie Canal is the quite rapid development of the Southern ports, such as Mobile, New Orleans, Port Arthur and Galveston. Since Jan. 1, 1899, the published rates which have obtained on export grain from Missouri River points have been the lowest ever known, and this was due entirely to the competition of the Gulf roads as against the lines leading east.

In the foregoing review of the correspondence of the expert commission relative to the best method of dealing with the state canals of New York, we have carefully refrained, for reasons already given, from expressing any opinion on the merits of the various arguments. The summary has necessarily been brief, but we believe it gives fairly the tenor of the answers received to the commission's circular of inquiry, and we leave our readers for the present to draw their own conclusions. It will, we believe, repay everyone interested in the future of New York's state canals to study the correspondence in its original form. Such a study, if it does nothing else, will explain the intricate nature of the problems to be solved and emphasize the importance of the most thorough study of the commercial and technical conditions which enter into its successful solution.

LETTERS TO THE EDITOR.

The Protection of Overhead Bridges from Locomotive Gases.

Sir: In regard to the editorial in your issue of July 20, referring to the protection of overhead bridges from locomotive gases, I enclose you two prints, one for a tunnel under the Erie Canal at Syracuse on the main line of the New York Central & Hudson River R. R., and the other of a bridge carrying Hoffman's Connection, between the main line of the New York Central and West Shore railways, over the four tracks of the N. Y. C. & H. R. R. R. You will notice that in both cases provision is made to protect the steel work from the gases of locomotives, according to designs by Mr. W. J. Wilgus, Chief Engineer, N. Y. C. & H. R. R. R.

The bridge at Hoffman's Connection, Fig. 1, is a double track, through plate girder, with a solid floor, and the specifications call for the "lower side of the floor and the lower flanges of the girders to be protected by galvanized

netting ⅝-in. mesh No. 8 wire, well covered with not less than two coats of Portland cement mortar, so as to cover fully the netting. The Portland cement mortar shall consist of 1 part of approved Portland cement and 1½ parts of clean, coarse, sharp sand." In the case of the Syracuse tunnel, we propose to use expanded metal set in Portland cement concrete, with cement plaster on the underside, as shown by Fig. 2. If the method used on the through girder on the Hoffman's Connection proves successful, we expect to adopt that for all our spans needing protection.

Respectfully,

Robert Giles,

Asst. Engineer, Bridge Department, N. Y. C. & H. R. R. R.

New York, July 25, 1899.

Sir: I have read your editorial on protection of overhead bridges from locomotive gases with a great deal of interest. You quote in it some remarks that I made on the Leonard Ave. viaduct in this city. I enclose you herewith a sample of scale from this bridge so that you can see

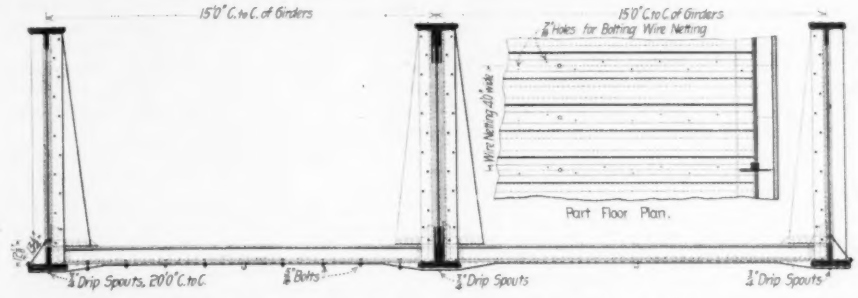


FIG. 1.—SECTION AND PLAN OF OVERHEAD BRIDGE, SHOWING METHOD OF PROTECTING METAL FROM CORROSION BY LOCOMOTIVE GASES; N. Y. C. & H. R. R. R.

that my remarks are in no way exaggerated. This scale is from a 3×2-in. angle, which, I presume, was originally about ¼-in. thick, possibly less. Fortunately the angle in question is at the bottom of the handrail, where it does not take up much strain. The other parts of the bridge were nearly as bad. I believe your suggestion to use brick arches is a good one. I suggested this construction in 1895 for the High St. viaduct here, but there was such a sentiment in favor of steel that no other plans were thought of or considered.

Yours truly,

Henry Maetzel, County Surveyor.

Columbus, O., July 24, 1899.

(The sample referred to by our correspondent consists of a handful of scales, many of which are fully ⅛-in. thick. These scales are laminated and so brittle that they may be easily crushed to powder by one's fingers.—Ed.)

Sir: Your article headed "The Protection of Overhead Bridges from Locomotive Gases" in the issue of Engineering News of July 20 brings before the profession probably one of the most difficult problems in the protection of metal structures which exist to-day. Especially is this the case when the bridge carries a roadway over railway tracks where the roadway and sidewalks are covered by a steel floor. The city of Philadelphia, in the design of its bridges, has for many years recognized the fact that some method of protection was necessary, specially where the head room over the locomotive was contracted, and where consequently the blast action of the locomotive would be correspondingly great.

In 1894, recognizing the necessity for protecting such bridges, plans were prepared and contracts awarded for two steel plate-girder bridges. One on the line of Girard Ave., over the tracks of the Philadelphia & Reading R. R., and the other on the line of 49th St., over the West Chester & Philadelphia branch of the Pennsylvania R. R., in both of which cases the headroom was extremely limited (16 ft.). Both bridges were painted with red lead and all metal work on the underside, excepting the columns and bents, was covered by a suspended ceiling of 1-in. white pine boards tongued and grooved and covered with two coats of asbestos paint. Three months after the application of the first two coats, when the boards had an opportunity to shrink, two more coats of the same paint were applied.

A few months ago an opening was cut in the Girard Ave. bridge directly over the tracks, and the steel within the ceiling was found to be in an excellent state of preservation. The boards forming the ceiling did not show any evidence of deterioration whatever, a clear, sharp cross cut showing the paint intact.

At the time these experiments were made the work on the subway alluded to in your article was in its inception, and the above-mentioned work was planned with a view of future light on this subject. The bridge plans on the subway were all made in 1895, and advertised in April, 1896, so that at that time the experiments had not progressed far enough to warrant any definite line of action. Just what method may be adopted to protect the above bridges has not been determined upon as yet.

In connection with this subject it might appear that the writer of the article referred to had not had his attention drawn to another point on the subway work where the work of protecting the metal of overhead work is completed. The roof of the tunnel is pierced with 13 openings for purposes of ventilation. On account of the character of the arch construction it was found to be necessary to span the tunnel with steel construction about 50 ft. long wherever a ventilation opening occurred. The metal work is here protected by means of a suspended ceiling of 4-in. beams with terra cotta between and covered with cement plaster. On top sufficient cinder concrete is used to give it rigidity. Exposed surfaces of the girders are covered with expanded metal in the center of a 2-in. coat of cement plaster, placed tight against the steel work, leaving no open spaces.

Yours truly,

George S. Webster,

Chief Engineer.

Department of Public Works, Bureau of Surveys, Philadelphia, Pa., July 27, 1899.

Sir: I notice in your issue of July 20 an editorial on "The Protection of Overhead Bridges from Locomotive Gases." This article is aimed in the right direction. As to the means of affording such protection you have made two suggestions; a wooden ceiling, and an expanded metal lath ceiling of incombustible plaster. But, why is a bridge of that type left open at the top? When you put a ceiling under the bridge, what will be the effect of it? The gases and smoke will be deflected and forced out at the sides, and the uprights will be exposed to these gases in a detrimental manner. The smoke which would ordinarily be thrown above a train would linger in the bridge and in the summer be annoying to passengers.

As to paint. I asked a foreman of a bridge painting gang on one of the leading railways in Illinois the other day if he ever scraped bridges. "Naw! Whut would yuh do that fur?" I pursued this ghost no further. I have a suggestion to make, and think it will answer all the objections made to the others. Every engineer knows asbestos. It will not burn; it is not a good conductor of heat; and it is readily adapted to almost any form wanted. It can be applied to any bridge, and will be a thoroughly practical protection, if creosoted to prevent its taking up moisture. It should be thoroughly applied, if it is applied at all.

I have been considering the protection of the roof system of any steel bridge, as well as the floor system of overhead steel bridges. Roof systems are never to my knowledge protected in modern construction. I have never heard of an application of asbestos for this purpose, but it ought to "stand the racket" in such a place when a sheet 1-16-in. thick will stand for years the constant contact with the blast of a gasoline stove.

I will admit it costs more than paint in first cost, but when one considers the saving in repairs on steel and the saving in paint and paint renewal, may I ask if the expenditure would not be wise?

I would be pleased to hear of any experiment along this line.

Geo. B. Herington, C. E.

Normal, Ill., July 28, 1899.

Apparatus for Taking Continuous Blueprints.

Sir: I would say for the benefit of D. L. E., who asks in your issue of July 27 for information concerning a continuous blueprint apparatus, that in the engineer's office of the Madison Division of the Chicago & Northwestern R. R., there is a blueprint frame so arranged with rollers at each end and a stationary pad and a hinged frame for the glass that blueprints can be made any length desired. The tracing and prepared paper are rolled up together on one roller, and after a section some 5 ft. in length is printed, they are rolled up together on the roller at the other end of the frame.

The whole apparatus is simple and inexpensive.

W. G. Kirchoffer, City Engineer.

Baraboo, Wis., July 29, 1899.

Sir: In answer to the query of D. L. E., in your last issue, I know a man who has been working on an apparatus for continuous blueprinting, and it now promises to be a complete success. He expects to find time to finish it in September, after which your correspondent could obtain more definite information.

Yours truly,

L. F. Rondinella.

728 Stephen Girard Building, Philadelphia, Pa.,

Aug. 1, 1899.

Notes and Queries.

F. A. D., Chicago, asks, what is the true definition of "rivet head." Is the head of the rivet the original head opposed to the point which has to be riveted over, or is it the head which is put upon the rivet by the boiler maker or bridge riveter? He would like a definition applicable to boiler and bridge construction.

TEST OF A PUMPING ENGINE AT CHICAGO, ILL.

The new pumping engine of 30,000,000 gallons daily capacity, which has been installed in the 14th St. pumping station at Chicago, by the Lake Erie Engineering Works, of Buffalo, N. Y., has been subjected to its duty and capacity test with satisfactory results. The contract requirements were as follows:

The duty required to be developed by the engine shall not be less than 135,000,000 lbs. of water raised 1 ft. high for each 1,000 lbs. of commercially dry steam, and shall have ample power and capacity to raise from the pump well, directly into the supply pipe system, not less than 30 million gallons of water per 24 hours, under a head equivalent to 150 ft. above the surface of the water in said well, with the steam pressure at throttle not to exceed 150 lbs. per sq. in.

In case the engine exceeds the duty above prescribed, then the city of Chicago agrees to pay to the contractors, as a reward for the superior efficiency of the engine, the sum of $1,000 for each million ft.-lbs. excess, or pro rata for any fraction thereof. In case the engine fails to perform a duty of 135 million ft.-lbs. per 1,000 lbs. of commercially dry steam, during the duty test, the contractors shall pay to the city of Chicago, as an agreed measure of damages, for lack of efficiency of the engine, in the ratio of $2,000 for each million ft.-lbs. which the duty falls below 135 million. A failure in capacity or duty exceeding 3% of the requirements of the contract and specifications, will subject the machinery to rejection by the Commissioner of Public Works, or to such forfeiture as said Commissioner, in his discretion, may determine.

As will be seen from the following record of the test, the guaranteed duty was exceeded by 17,952,000 ft.-lbs., which entitles the builders to a bonus of $17,952 above the contract price. The test was conducted by Mr. F. W. Cappelen, M. Am. Soc. C. E., of Minneapolis, Minn.; Mr. Newcomb Carlton, of Buffalo, N. Y.; and Mr. J. C. McMynn, of R. W. Hunt & Co., Chicago. We are indebted to Mr. McMynn for a copy of the full report of the test, which we abstract as follows:

The engine is of the vertical, triple expansion, direct acting, crank and fly-wheel type, with plunger pumps. It has three steam cylinders, in which the pistons are double acting, and three water plungers which are single acting, all being on vertical axes. The steam cylinders

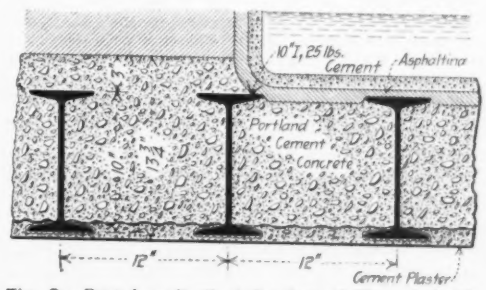


Fig. 2.—Part Longitudinal Section of Tunnel Roof, Showing Protective Construction against Corrosion; N. Y. C. & H. R. R. R.

are placed side by side, on A-frames, vertically over the pumps, and each piston is connected rigidly to its corresponding water plunger. Between the steam cylinders and the pumps is the crank shaft carrying two flywheels. The cranks are 120° apart and each is connected by a connecting rod to its corresponding cross-head, which works in guides in the cast-iron frames. Each piston is connected to its cross-head by two piston rods, and the connection from the cross-head to the water plunger below is made by four rods, two on each side of the crank shaft.

The suction pipe enters the pump chamber under the high pressure cylinder, and follows through the chamber under the intermediate cylinder into the chamber under the low pressure cylinder. The pumps discharge directly into the street mains. All water plungers are outside packed. All the steam and exhaust valves are of the Corliss type, and are placed in the cylinder heads. The cut-off of the high pressure cylinder is controlled by a governor, while the cut-offs on the intermediate and low pressure cylinders are adjustable by hand. The cylinders

are all steam jacketed, and reheaters are placed between the cylinders. The feed pump, air pump, etc., are driven from an arm on the low pressure plunger cross-head.

Steam was supplied by two horizontal tubular boilers, provided with Roney mechanical stokers. Each boiler had three drums, 3 ft. 6 ins. diameter, and 23 ft. 3 ins. long, and 81 tubes 4 ins. diameter and 18 ft. long. Heating surface, 1,783 sq. ft.; grate area, 34 sq. ft. The principal dimensions of the engine are as follows:

No. of cylinders	3
Diameters of cylinders	34, 60 and 94 ins.
Stroke of all pistons and plungers	60 "
Diameter of plunger	42 "
" " all piston rods	5 "
Net area of h. p. piston	1,776.57 sq. ins.
" " " int. p. "	5,615.59 " "
" " " l. p. "	13,840.29 " "
Area of all plungers	4,156.32 " "
Clearance in h. p. cylinder	2.84%
Clearance in int. p. "	2.44%
Clearance in l. p. "	2.04%
Total area clear opening of suction valves	5,820.75 sq. ins.
" " " " " discharge "	5,620.75 " "
Diameter of steam pipe at throttle	10 "

Fig. 1.—Racer Casting for the Ordnance Department, U. S. A.
Cast at the Foundry of the American Hoist & Derrick Co., St. Paul, Minn.

In order to obtain the specified head for testing, it was necessary to throttle the discharge somewhere in the street. Telephone communication was established between the pumping station and the valve in 12th St., and the head was kept as near the amount specified as was possible by closing the valve. The discharge head was obtained by means of a pressure gage attached to the discharge air chamber, and the difference of water levels in the air chamber and in the suction well was obtained by reading the water level in the gage glass attached to the air chamber, and the reading on a rod graduated to feet and tenths attached to a copper float in the suction well—both readings being taken from the same datum level. The pressure gage was carefully calibrated before and during the test and the necessary corrections applied.

The steam consumption was obtained by weighing the feed water in tanks set on platform scales. All connections to the feed water pipe and the pumps were broken or blanked so that there was no possibility of gain or loss of feed water. The drain pipe from a steam separator in the steam main was led back to the tank receiving the weighed feed water, so that no correction for entrained water was necessary. A steam calorimeter placed near the throttle valve showed that the steam was commercially dry, so that no correction was made. Careful watch was kept of the feed water pump, to see that no leak occurred there. The water purifiers on the boilers were closed and the drain opened to the atmosphere. The engine running the stokers obtained its steam from other boilers than those being tested.

The coal used was Baltimore & Ohio nut, and was carefully weighed, as were also the ashes obtained. A sample of 100 lbs. of coal was put upon the boilers and allowed to dry for 24 hours, thus obtaining the moisture in the coal.

Gages, counters and temperatures were read every 15 minutes during the first half of the test, and every 30 minutes during the latter half. The water pressure and air chamber level, however, were read every five minutes, except during the time the gage was being tested. The water leaking around the plungers was measured, and the amount thus obtained subtracted from the calculated plunger displacement. The valves were examined immediately after the test, and were all found to be intact and practically tight.

There being no means of measuring the water pumped other than the plunger displacement, the test has been figured on that basis.

Results of Duty Trial of Pumping Engine.

1.—Duration of trial, hrs.	24
2.—Steam press. at engine by gage, lbs.	159.85
3.— " " " " corrected, "	149.85
4.—Pressure in 1st receiver by gage, "	34.85
5.— " " 2d " " " "	5
6.—Vacuum by gage, ins.	26.68
7.—Press. in h. p. jacket & 1st reheater by gage, lbs.	151.58
8.— " " i. p. " " 2d " " " "	73.1
9.— " " l. p. " lbs.	34.54
10.—Water pressure in air chamber by gage, lbs.	62.499
11.— " " " " corrected, "	60.899
12.— " " " " ft.	140.615
13.—Water level in well below indicator point, ft.	13.624
14.— " " " air chmbr. below ind. pt., "	1.171
15.—Total head on pump, ft.	153.068
16.—Av. steam press. in boilers, lbs.	157.7
17.—Atmospheric pressure, lbs.	14.6
18.—Absolute steam press. in boilers, lbs.	172.3
19.—Draft in stack, ins.	.457
20.—Temp. of water pumped, Fahr.	39
21.— " " feed water, Fahr.	79.5
22.— " " flue gases, "	575.
23.— " " steam, Fahr.	369.
24.—Total feed water, lbs.	273,307
25.—Steam used by calorimeter, lbs.	20
26.—Net feed water, lbs.	273,287
27.— " " per hour, lbs.	11,387
28.—Feed water for first half of run, lbs.	138,613
29.—Jacket " " " " "	20,070
30.—Per cent. of jacket water	14.47
31.—Total coal burned, lbs.	39,532
32.—Per cent. of moisture	9.5
33.—Dry coal burned, lbs.	35,776.5
34.— " " " per hour, lbs.	1,490.7
35.—Total ash, lbs.	3,687
36.—Per cent of ash	10.3
37.—Total combustible, lbs.	32,089.5
38.—Combustible per hour, lbs	1,337.0
39.—Revolutions in 24 hours	30,317.5
40.—Average revolutions per minute	21.054
41.—Plunger displacement per rev., U. S. gals.	1,079.564
42.— " " " " cu. ft.	144.315
43.— " " " " lbs.	9,008.957
44.—Total pumped in 24 hours, gallons	32,728,681.
45.— " " " " lbs.	273,129,053.9
46.—Leakage around plunger in 24 hours, lbs.	48,800
47.—Net water pumped in 24 hours, lbs.	273,080,253.9
48.—Work delivered in 24 hours, ft.-lbs.	41,799,848,304
49.—Delivered horse-power	879.6
50.—Steam per D. HP. per hour, lbs.	12.83
51.—Coal " " " "	1.69
52.—Combustible per D. HP. per hour, lbs.	1.52
53.—Per lb. steam at 164.45 lbs. absolute above 0° F.	1,225.4
54.— " " of feed water at 79.5° F.	79.5
55.— " " of steam used by engine	1,145.9
56.—B. T. U. used by engine in 24 hours	313,161,865
57.—B. T. U. " " " per hour	13,048,411
58.—B. T. U. " " " " minute	217,473.5
59.—B. T. U. per D. HP. per minute	247.3
60.—B. T. U. per lb. coal	12,411
61.—B. T. U. supplied in 24 hours	444,022,141
62.—B. T. U. " per hour	18,501,077
63.—B. T. U. absorbed by steam per hour.	13,073,453
64.—B. T. U. transmitted per sq. ft. of heating surface per hour.	3,632
65.—Coal burned in 24 hours, lbs.	35,776.5
66.—Ashes in 24 hours, lbs.	3,687
67.—Combustible burned in 24 hours, lbs.	32,089.5
68.—Coal burned per hour, lbs.	1,490.7
69.—Combustible burned per hour, lbs.	1,337.0
70.—Coal burned per sq. ft. of grate per hour, lbs.	21.92
71.—Combust. burned per sq. ft. of grate per hr., lbs.	19.72
72.—Coal burned per sq. ft. of heating surface per hour, lbs.	.418
73.—Combustible burned per sq. ft. of heating surface per hour, lbs.	.375
74.—Feed water in 24 hours, lbs	273,307
75.— " " " per hour, lbs.	11,387.8
76.— " " " per lb. coal, lbs.	7.64
77.— " " " " " combustible, lbs.	8.52
78.— " " " " sq. ft. of grate per hour, lbs.	167.46
79.— " " " " " " ht. surf. per hr., lbs.	3.19
80.—Factor of evaporation	1.188
81.—Equiv. evap. from and at 212° per hr., lbs.	13,537.8
82.—Evap. from and at 212° per lb. coal, lbs.	9.08
83.— " " " " " " " combust., lbs.	10.12
84.— " " " " " " sq. ft. grate per hour, lbs.	196.14
85.—Evap. from and at 212° per sq. ft. heating surface per hour, lbs.	3.79
86.—Ft.-lbs. per 1,000 lbs. feed water	152,952,000
87.— " " 100 lbs. coal.	111,245,000
88.—Ft.-lbs. per 1,000,000 B. T. U. supplied by coal	94,137,000
89.—Ft.-lbs. per 1,000,000 B. T. U. supplied by steam	133,445,000

A DIFFICULT PIECE OF FOUNDRY WORK.

We show in the accompanying cut, Fig. 1, a large casting made at the foundry of the American Hoist & Derrick Co. The piece is a "racer," or portion of a gun platform, 30 of which have been cast at these works for the Ordnance Department, U. S. A. The casting is 14 ft. in diameter, and about 2 ft. thick, and its total weight is 15 tons. The interior is hollow, and the mold is filled with dry sand cores, which are vented through the round holes seen in the finished casting. The side exposed is the top side. On the under side is a beveled roller path which rests on a ring of 24 steel rollers.

The specifications for the metal for these large castings require them to be made from

gun iron, by which is meant charcoal iron prepared in an air furnace, or by such other process as will give an elongation of not less than 0.25 of 1% under stress before rupture. The elongation is tested from a cylinder, 20 ins. long by 9 ins. diameter, with a 2-in. axial core, taken from each ladle of cupola iron, so as to fairly represent the iron in the casting. From these cylinders specimens are prepared with stems 10 ins. long, 1.129-in. diameter.

The specifications also require the castings to have coupons attached which shall show a tensile strength of not less than 28,000 lbs., and not more than 39,000 lbs. The required elongation is usually reached under a strain of about 20,000 lbs.

Fig. 2 shows the mold in which these large castings are made, ready for pouring. It will be seen that heavy girders are passed across the top of the cope and similar girders are buried beneath the flask, and the two sets are clamped together at the ends to obtain the necessary strength to hold down the cope.

In order to insure that the interior of the casting shall be clean, sound iron, free from dirt and slag, an overflow channel is attached to the mold, as seen in Fig. 2, and the metal runs into this as it rises in suitably-placed vent holes. This overflow leads to a small pig bed. The casting is poured at two places by two ladles simultaneously, and the pouring is continued until about five tons has run off into the pig bed from the overflow.

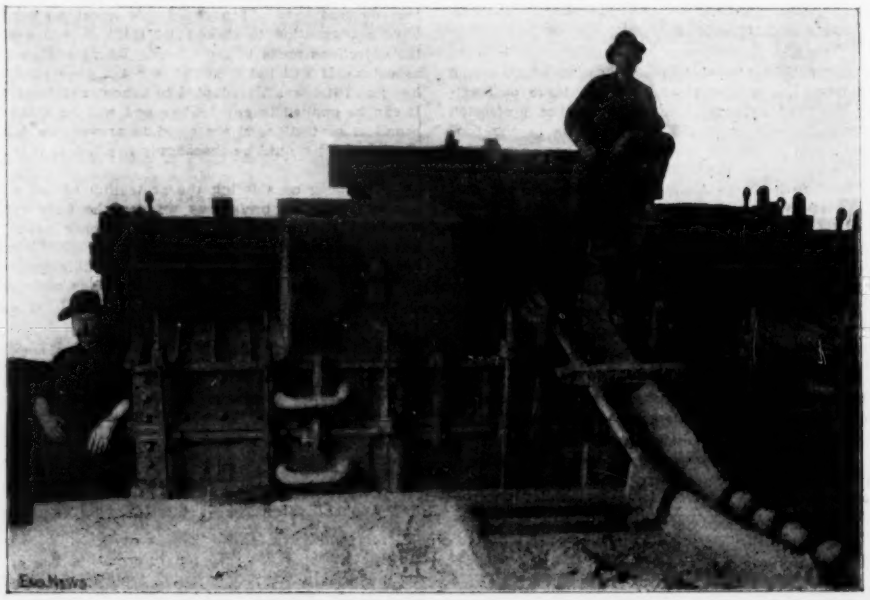
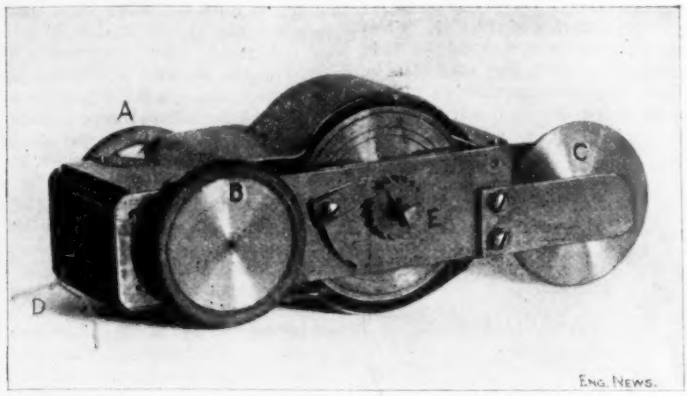


FIG. 2.—MOLD READY FOR POURING RACER CASTING, SHOWING OVERFLOW.

We are indebted to Mr. Oliver Crosby, President and Engineer of the American Hoist & Derrick Co., St. Paul, Minn., for the excellent photographs which are here reproduced, and for the information from which this description has been prepared.

A CARRIER FOR HAULING WIRES THROUGH CONDUITS

We illustrate in the accompanying engraving a simple carrier for hauling wires or cables through small conduits, which has been designed by Mr. W. L. Mulligan, Chief Electrician, of the United States Electric Co., of Springfield, Mass., and is now being used in laying about six miles of new conduit line, which that company is putting in. This carrier, as will be seen from the illustration,



TRAVELER FOR HAULING WIRES THROUGH ELECTRICAL CONDUITS.
W. L. Mulligan, Springfield, Mass., Inventor.

consists of a large spiral spring held between two side frames and geared to two driving wheels, A, B, in such a manner that the carrier runs along the bottom of the conduit as the spring unwinds. The spring is of such power and the gears are so arranged that the machine can easily run from one manhole to another. The front wheel C is made large enough to run over any poor joints in the conduit, and as it is in the center, it acts as a guide. The driving wheels have rubber tires to give the necessary adhesion and to prevent them from slipping. In using the carrier the spring is wound up by a key fitted to the head E, and when put in the conduit and released it will run through the tube, pulling the string D after it. A man at the next manhole catches the traveler, and pulls the string through, a wire being attached to the string and a cable attached to the wire.

A SIMPLE DESIGN FOR A TIMBER ROOF TRUSS

By Gunwald Aus, M. Am. Soc. C. E.*

The recent high prices for steel construction have in a measure forced wood to the front again, and the writer at least has had the first opportunity in a great many years to design some wooden trusses, and in so doing he found himself able to improve very much upon the ordinary details. Perhaps other engineers have also been obliged to resort to wood construction in order to bring the expense of their structures inside the limits fixed, and to them the details, a sketch of which is sent you, will perhaps be of interest, as they are very simple. The ordinary carpenter, with no better tools than an auger, a saw and a chisel, can do all the work. The end shoe can on a pinch be omitted, and a wrought washer plate be substituted. It is possible that some one may have used similar details, but in that case they have not been made public. If the details have any weakness which has been overlooked, the writer would be very much pleased to have it pointed out.

A SIMPLE RIVET HEATING FURNACE.

A furnace for heating rivets is described in the "Organ fur die Fortschritte des Eisenbahnwesens." It is rectangular in shape, with a base about 2 ft. square; and is made of refractory materials enclosed in a sheet-iron casing, and is supported by four angle-iron legs. At the bottom is a grate and the fuel is fed in through the opening O, fitted with a door and a register for regulating the entrance of air, above the fire, in such manner as to insure complete combustion without producing smoke.

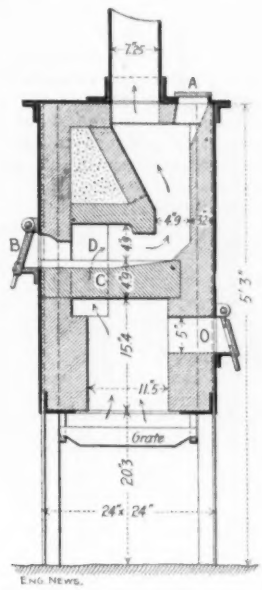
The cold rivets are introduced at A; they are gradually heated and descend upon the floor C, and when sufficiently hot they are extracted through the door B. The flames from the furnace heat the floor C and then pass up by the two lateral ducts D, impinge directly upon the rivets, and then escape by the chimney above. The heating is effected in a regular, methodical and rapid fashion, says "Le Genie Civil," to which we are indebted for the cut used, and the rivets never come into contact with the fuel. This furnace, in a day of 10 hours, will heat about 350 rivets of 0.7 to 0.8 in. diameter; enough to supply two sets of hand-riveters.

*Supervising Architect's office, Washington, D. C.

THE HASTINGS TUNNELING SHIELD.

One of the most important accessories to modern tunneling operations is the tunnel shield, which enables the excavation to be pushed on through soft and treacherous material. The tunnel shield dates from Brunel's sectional shield for the Thames Tunnel in 1825; the 8-ft. circular shield for the Thames Subway in 1868, and Beach's shield used in the commencement of the first attempt at a New York underground railway, about 1870. In the Thames Subway (at the Tower), constructed in 1868-69, by Mr. Peter Barlow and Mr. J. H. Greathead, a shield pushed forward as one structure was used for the first time, and this was also the first tunnel in which a cast-iron lining was used, the exterior diameter of the rings being 7 ft. 1¾ ins. The tunnel was driven through the London clay for its entire length, and no water had to be dealt with, nor were any serious difficulties encountered. The shield was forced forward by means of jack screws. Within recent years, great changes and improvements have been introduced. These improvements were discussed in our issue of Jan. 16, 1892, and various forms of shields, as used in the St. Clair, Hudson River, Baltimore, London, and other tunnels, have been illustrated and described in our columns.

We illustrate this week the latest form of tunneling shield, which is now being used in the 20-ft. intercepting sewer at Chicago. It is the invention of Mr. Cornelius G. Hastings, of Chicago, whose first patent was issued Sept. 28, 1897, and a second patent, (No. 626,063, May 13, 1899), has been allowed. Other patents have been secured, covering the double shell, the flexible hood, and other details, and the shield may be adapted to many special conditions of working. Mr. Hastings was employed as a foreman on the

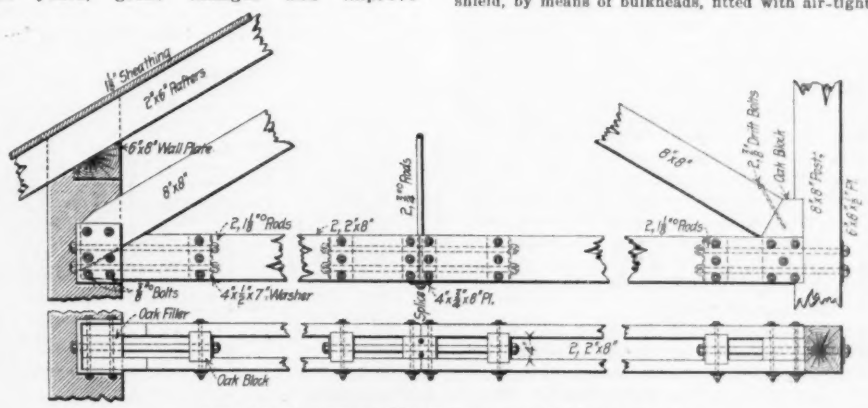


Vertical Section of Portable Rivet Heating Furnace.

construction of the St. Clair tunnel, and has had considerable experience in this class of work. For information respecting the shield we are indebted to Mr. Hastings, and to Mr. W. H. Rowe, patent attorney, 1401 Monadnock Block, Chicago, Ill.

The most striking feature of the Hastings shield is the use of a double shell, connected at the cutting edge so as to form a bell mouth. The jacks are fitted within the annular space between the shells. The improvements covered by the Hastings patents are of special advantage in the excavation of sand, gravel, silt, and similar loose, soft or crumbling soils. The objects of his invention are stated as follows:

1. To provide a very strong, light and comparatively inexpensive shield, by the use of a double shell extending the full length of the shield.
2. To divide the shield by one or more transverse bulkheads, braced in a novel manner to resist the extreme pneumatic pressure and the force of concussion for blasting, and to present a smooth concave face upon the forward side of the bulkhead so as to prevent the lodgment of material within the shield.
3. To provide an intermediate chamber within the shield, by means of bulkheads, fitted with air-tight doors. Within this the workmen may take refuge from the working face of the shield, and may be supplied with air at a suitable pressure, while an excessive pressure may at the same time be maintained forward of the shield while the work is in progress, or behind the shield to assist in forcing it forward.
4. To provide suitable means for regulating and directing the movement of the shield, for lessening the friction upon the outer surface, and for changing the grade and alinement of the tunnel if required.



IMPROVED DETAILS FOR A TIMBER ROOF TRUSS.
Gunwald Aus, M. Am. Soc. C. E., Washington, D. C.

Fig. 1 is a view of the shield which is now in use in the 39th St. intercepting sewer tunnel in Chicago, the view having been taken during the con-

struction of the shield. Fig. 2 is a longitudinal section of the shield, and Fig. 3 shows cross sections at X—X and Y—Y. Fig. 4 shows the front and rear elevation.

One of the principal features of the shield is that it has a double shell, formed of two concentric cylinders, (A) and (B), with radial diaphragms (C) in the annular space between them. These shells are connected to the rear bulkhead (D) and to a curved or dished plate (E) at the forward end. This latter forms a trumpet-shaped opening or bell mouth connecting the two shells, and its outer edge forms the cutting edge of the shield. Its flaring surface is fitted with radial cutters (F) (F). This arrangement is designed to direct the material into the working chamber. The front bulk-

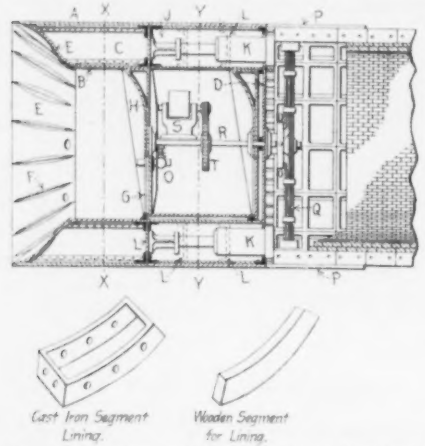


Fig. 1.—Longitudinal Section of the Hastings Tunneling Shield.

head (G) has on its outer face a concave hood (H) and is braced at the back by vertical angle irons, which may serve as guides to the sliding air-tight doors.

The rear bulkhead (D) is double, with an air space between the two parts, and on the inner face is a hood similar to that of the front bulkhead. This arrangemnt is designed to resist the high pneumatic pressure when this is used to help the jacks in forcing the shield forward, and also to resist the concussive force from blasting in the heading. The two cylindrical shells are connected by radial diaphragms (C) forward of the front bulkhead. Between the two bulkheads they are connected by longitudinal arched or cradle plates (J), which form compartments for the hydraulic jacks (K) which are placed at equal intervals around the shield. Each jack has a head fitted to the main piston, which rests against the tunnel lining. The plates (C) and (J) are in the same planes, so as to transmit the thrust of the rams to the cutting edge. Annular diaphragms (L) are fitted in the space beween the shells, the front diaphragm being in the same plane with the front bulkhead.

Air pipes (M) extend through the lower portion of the shield, while above them are larger pipes (N), through which water, quicksand or soft earth may be forced by the air pressure in the heading. The pipes (M) may be closed at the end, and fitted with caps and nozzles for attaching hose for pneumatic drills, etc. The bulkheads may be fitted with pipes and stop-cocks (O) to admit air from one chamber to another.

At the rear of the shield is the hood (P), which is formed of a series of narrow steel plates, set close enough together to prevent loose earth from falling between them, as shown in Fig. 5. These plates can be slightly bent when the shield is changing its grade or is working on a curved alinement, so that the hood will bend in the excavation.

Behind the rear bulkhead is the rotary crane (Q) for placing the segments for iron tunnel lining. It is mounted on a shaft (R) journaled in the two bulkheads, and driven by a suitable machine (S) within the shield, by means of gearing (T). The details of this crane are shown in Fig. 6. At each end of the arm is a block (1) carried by a plate (2) fitting between the two side plates (3) forming the arm, which are slotted to receive the pin (4). The block has two cross plates (5) forming a T-head, the plates being slotted and fitted with clamp nuts. They also have studs to engage with the bolt holes in the lining segment. The block (1) is adjusted to any required distance from the center of the shaft by means of the rod (6), the outer end of which is bolted to the block, while the inner end is hooked and travels in the spiral groove of the hand wheel or disk (7). At (8) are the guides for the rod and arm. By this arrangement the blocks at the opposite ends of the arm are simultaneously drawn inwards or forced outwards by the rotation of the disk. When in position, the arms may be locked to the disk, so that they will revolve with it and may thus be turned to any part of the circumference of the tunnel. The blocks being drawn inward, one of

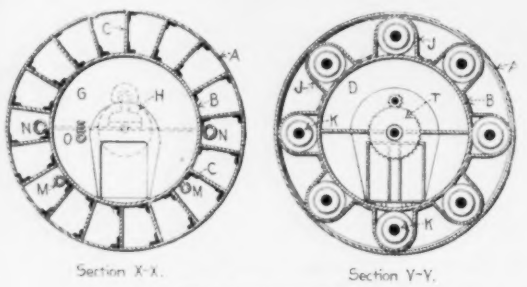


Fig. 2.—Cross Section.

the iron lining segments is placed upon the end of the arm, which is then revolved until the segment is opposite the position it is to occupy. The disk is then released from the arm, and by revolving it the block, with the segment, is forced outward, thrusting the segment into place, ready for riveting. The plates (5) are then withdrawn, releasing the block from the segment.

The crane is not necessary when brick is used for lining the tunnel, and the crane and the two bulkheads may all be omitted when the shield is working in hard ground. The double cylindrical shell and the curved cutting edge serve to compress loose earth or similar material, so that the

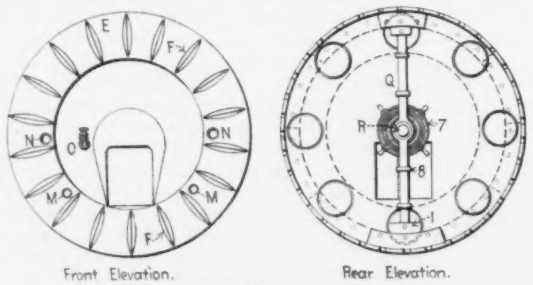


Fig. 3.—Front and Rear Elevation.

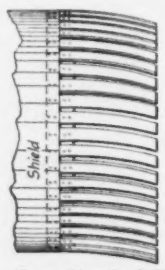


Fig. 4.—Rear Hood of Shield.

material holds the air better in the heading, under pneumatic pressure.

Two Hastings shields are now in use in the 20-ft. intercepting sewer along 39th St., Chicago. This sewer was described in our issue of April 21, 1898. It will be about 13,855 ft. long, of which only about 3,000 ft. will be executed in open cut. The headings are being run east and west from a single shaft at the intersection of 39th St. and Calumet Ave.

The two shields are identical in construction. The outer shell is 24 ft. 9 ins. diameter and 10 ft. long, with the steel hood (P) 4 ft. long. The annular space between the shells is 22 ins. wide. The outer shell and the ram plates are of 1-in. steel. The inner shell, partitions, etc., are of ½-in. steel. No bulkheads are used, not being considered necessary, since the tunnel is entirely under land.

There are 24 jacks of 125 tons capacity, and the average pressure in advancing is 60 tons. In moving, two men control the jacks, while the foreman sights the lines to see that the shield moves properly. A movement of 24 ins. can be made, but it is usually much less, the shield being advanced short distances at frequent intervals. The tunnel has a lining of five brick rings, outside of which is an 8-in. lining built up of wooden segments. The object of this is to take the thrust of the jacks, thus preventing any liability of cracking or injuring the green masonry by this pressure. The timber lining is built within the steel hood behind the shield, with a lap of about 3 ft. 6 ins., so that when the shield is moved forward it will not be separated from the lining. This lining is kept 4 or 5 ft. in advance of the brickwork, under present conditions.

The shield working east from the Calumet Ave. shaft encounters a fine, water-bearing drift sand, and a gravelly sand, underlaid by blue clay. The shield working west from the same shaft encounters mainly a stiff blue clay. An air pressure of 10 lbs. per sq. in. is maintained in the tunnel, in order to hold the water back, and the trumpet mouth of the shield seems to compress the sand and make it more easily handled. The work is carried on in three shifts of eight hours each, with 35 to 40 men in a shift, and the progress is at the rate of about 9 ft. in 24 hours for each shield. It is expected that more rapid progress will be made as the work advances. The clay is excavated by semicircular knives of the form used in the St. Clair tunnel (Eng. News, Dec. 27, 1890) and the spoil is run out in cars, stagings being built for the three upper working levels or floors of the shield.

The tunnel is being built by the Chicago Star Dredging & Construction Co., and Mr. T. H. Murphy, who was superintendent on the St. Clair tunnel, is in charge for the contractors. The work is under the general supervision of Col. R. O'S. Burke, Superintendent of Sewers, and Mr. W. Shaw is the engineer in charge at the tunnel. Mr. Wm. Lowe is Engineer in Charge of the Division

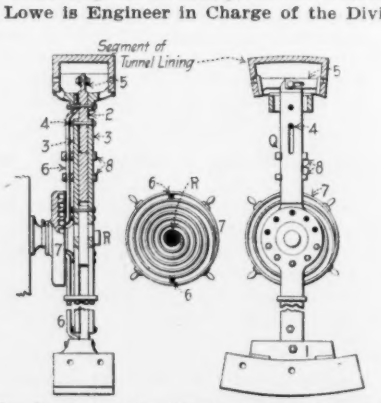


Fig. 5.—Crane for Handling Segments of Iron Tunnel Lining.

of Intercepting Sewers of the Bureau of Sewers. It is all under the jurisdiction of Mr. L. E. McGann, Commissioner of Public Works.

The shields were built by the Tobin & Hamler Mfg. Co., of Chicago, and cost about $7,400 each, $4,000 being for the shields proper and $2,400 for the jacks.

A TILE ROOF WITHOUT SHEATHING.

We illustrate herewith an interesting form of roof construction which is coming into extensive use for factories, railway shops, etc., and which is of very simple design. It consists in the application of tiles directly to the iron roof framing, without the use of any sheathing under the tiles.

Fig. 1 shows this construction as applied to a roof of 64 ft. span. The trusses are connected by nine purlins of 10-in. channels, which carry three lines of rafters, consisting of 4-in. channels, parallel with the top chords of the trusses. Upon the rafters are laid longitudinal lines of angle irons ¼ × 1⅜ × 1⅜ ins., spaced 13⅜ ins. c. to c. Directly upon these are laid the tiles, as shown, these being of such form as to interlock with each other and form a watertight joint. Every

fourth tile is secured to the angle irons by a piece of copper wire passed through a lug in the tile and wound around the angle iron. No cement is required to make a watertight roof, but in exceptional cases the joints may be pointed on the under side to make them proof against dust and fine snow.

The tiles are of hard burned terra cotta, 9 × 16 ins. in size, or 135 pieces to the square (10 × 10 ft.) Fig. 2 shows the form of one of the tiles.

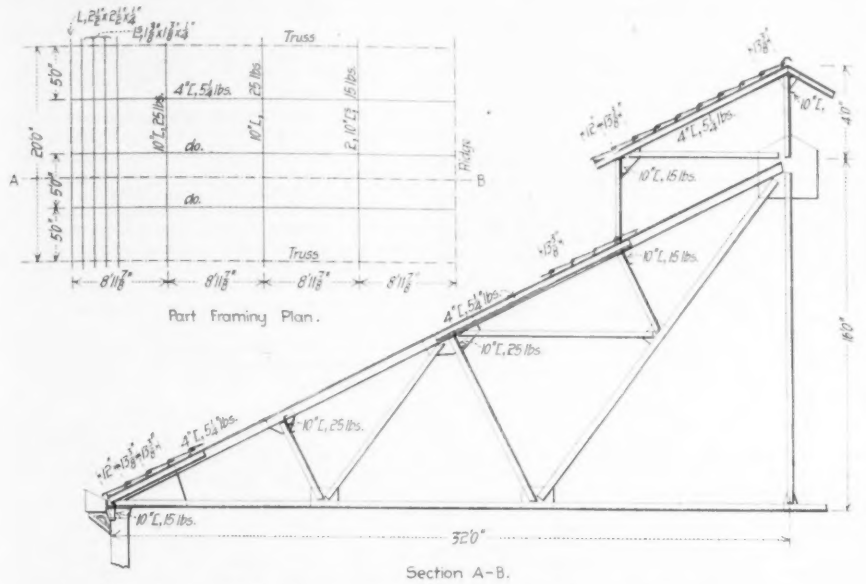


FIG. 1.—ROOF FRAMING FOR LUDOWICI TILE COVERING.

The weight is 750 to 800 lbs. per square, and the cost $6 per square at the factory. The upper surface of the tile is made either plain or glazed, as desired. The Burlington station at Omaha, Neb. (Eng. News, May 4, 1899), has a roof of brown glazed Ludowici tile. The tile is slightly absorbent, sufficiently so to absorb any condensation collecting on the outside, so that there is no dripping of moisture. The tendency of moisture to condense on the tile is also reduced by the fact that the material is a sufficiently good non-conductor of heat to insure the under surface being kept warm even in cold weather. Even with the unglazed tile, owing to the slant of the tile, no water penetrates from the outside either under heavy rain or melting snow.

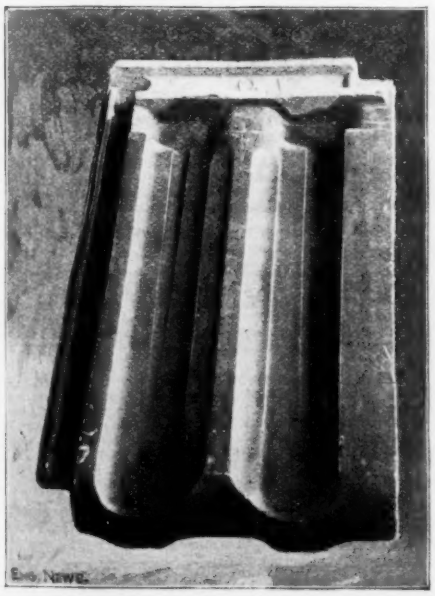


Fig. 2.—View Showing Form of Ludowici Tile.

Fig. 3 shows this tile roofing completed and in progress on the new shops of the McCormick Harvesting Co., at Chicago, where 1,000 squares are used. It is also in use at the new plant of the Chicago Portland Cement Co., and the new shops of the Chicago Great Western Ry., at Oelwein, Ia., the latter shops taking 1,200 squares of the tile roofing. One of the electric light stations in Chicago had this roofing put on in March, 1894, and has required no attention up to the present time. In this case the joints are pointed on the under side to prevent fine snow from sifting in during high winds and falling on the dynamos. The superstructure of the new intake crib at Chicago will have these clay tiles over the building, while Ludowici glass tiles of the same shape will be used over the well. The glass tiles are also being used for train sheds.

For photographs and particulars of this tile roofing we are indebted to the manufacturers, the Ludowici Roofing Tile Co., 419 Chamber of Commerce Building, Chicago, Ill.

ROTARY TRANSFORMERS AND STORAGE BATTERIES FOR LONG-DISTANCE TRANSMISSION.*

By William Lispenard Robb, M. Am. Inst. E. E.†

At the present time there is in operation at Hartford, Conn. an electric lighting system which employs a storage battery plant charged by rotary converters which receive alternating current from a hydraulic generating station on the Farmington River, approximately eleven miles from Hartford. The water power at present developed is capable, under the most favorable conditions, of delivering at the switchboard in Hartford about 1,200 electric horsepower. The power is generated by two 600-K-W. 60-cycle alternators and transmitted over a three-phase system at 10,000 volts pressure.

The water power is supplemented by an auxiliary steam plant in Hartford, consisting of two compound-condensing Cooper-Corliss engines, having a combined capacity of 1,600 HP. These engines supply the power to operate one 600-K-W. alternator and one 400-K-W. rotary transformer, so arranged that it can be connected with engines and operated as a direct or alternating-current generator. This rotary is so operated whenever, owing to low water or repairs on the transmission line, the supply of alternating current is insufficient for the alternating-current load and all the rotary transformers.

Two systems of distribution are used. In the central portion of the city the distribution is on the three-wire, 220-volt, direct-current system. This part of the service is practically all underground. The feeders are lead-covered cables drawn into cement-lined ducts. The distribution is in part by Edison tubes and in part by lead-covered cables drawn into ducts. Outside the central portion of the city the feeders are supplied with two-phase alternating current under 2,400 volts pressure, and the distribution is, in general, on three-wire, 220-volt systems, supplied from 10 or 20-K-W. transformers, although a few smaller transformers are still in service. This service is in part underground, but is in general overhead. Constant-potential, inclosed-arc lamps, incandescent lamps and motors, in the case of both alternating and direct currents, are operated on the same three-wire system. All the commercial arc lamps, whether on the direct or alternating system, are of the constant-potential, inclosed type, as are also the street lamps in streets in which there is a three-wire system. In other streets the street lamps are of the series alternating-current, inclosed-arc type, and are operated from constant-current transformers.

*Abstract of a paper read before the National Electric Light Association at its 22d Convention.

†Prof. of Physics, Trinity College, Hartford, Conn.

Three rotary transformers supply direct current to the three-wire, direct-current system. One has a capacity of 400 K-W., and is located at the steam plant. Two have a capacity of 250-K-W. each, and are located in a battery sub-station which is situated in the very heart of the business section of the city, and about ¾ mile from the steam plant. The storage battery has a capacity of 2,500 HP. hours at a five-hour rate of discharge. All three rotaries and the battery supply currents to the same three-wire system.

The three alternators are always operated in parallel. At least one rotary transformer and storage battery are always connected to the 3-wire, direct-current system. The direct and alternating-current systems are consequently interlocked, and the whole plant, including alternators, rotary transformers and battery, is practically operated in parallel.

The rotary transformers are of the two-phase type, and are so designed that by cutting in or out turns of the primary of the static transformers the voltage of the rotaries may be varied between 230 and 360 volts. This wide range of voltage is necessitated by the fact that the rotaries are at times run directly on the line, and at other times used in charging the battery, frequently at high charging rates. The wide range of voltage that can be obtained from the rotary does away with the boosters which would otherwise be necessary for charging.

The rotary transformers are 2-wire, and simply supply the current to the outside wires of the 3-wire system. The neutral wire is connected with the middle point of the secondaries of the two static transformers. This point is always midway, as regards electric pressure, between the two terminals of the rotary transformer.

The storage battery is at all times kept on the line for the purpose of regulation, and to meet any emergency call for extra power.

It was necessary to generate alternating current rather than direct current, as the main source of power is located 11 miles from the center of distribution. This condition very generally applies to water powers that have not already been developed for other purposes than the production of electricity. The same condition applies in the case of companies supplying large areas when it is desired to supply all the power from one central power plant, so located that the power can be produced at the minimum cost.

Two of the rotaries are started and brought into synchronism by induction motors built on their shafts; the third is brought into synchronism as a direct-current motor, the current necessary for this being supplied from the direct-current system.

The direct-current system of distribution was adopted for the central portion of the city, as it was considered the only one on which all kinds of service could be given from the same wires, especially if those wires were placed underground. In that section of the city a large number of motors are being frequently stopped and started. It is considered that induction motors operated under these conditions would seriously interfere with the lighting service. In sections of the city where the motors are in continuous use—for example, when they are used for running machinery in factories, and consequently are only started twice a day—no practical difficulty in operating induction motors and lights from the same system of distribution is experienced.

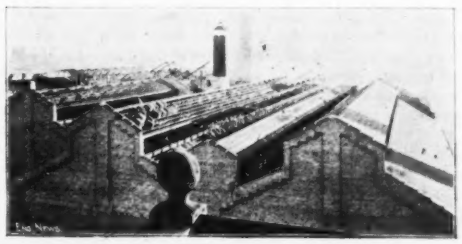


Fig. 3.—Tile Roofing on the Shops of the McCormick Harvesting Co., Chicago.

Ludowici Roofing Tile Co., Manufacturers.

The three alternators, one operated by steam and the other two operated by water power at a distance of eleven miles from the first, have been continuously run parallel during the past three years. No difficulty whatsoever has been found in this method of operation.

The operation of the rotary transformers has not been so simple a matter. At the outset there was great excess of sparking at the commutator. This sparking was soon found to depend very largely on the variety of brushes

used. It was found that a very soft carbon brush gave the best results, but without special treatment of the brushes, sparking, although diminished, is still excesive. The method of treating the brushes suggested by our superintendent, Mr. Rollins, was tried and found effective. The carbon brushes are first raised to a red heat, and then plunged in ordinary lubricating oil and allowed to cool. When brushes treated in this manner were used, all vicious sparking was stopped, and in this particular the transformers ran as smoothly as direct-current generators of the best type. At the outset, in operating the rotaries, considerable difficulty was met with in preventing pumping when the engines were supplying power to the system. This pumping could be traced to the variation in the angular speed of the engines, and was absent when the water power alone was supplying the power. It was found that this tendency to pumping could be checked by varying the field excitation of the rotary transformers or by temporarily throwing a portion of the load on the storage battery. Only once in the past three years has the pumping been such as to cause any serious interruption.

The switchboard at the sub-station was originally arranged to give the greatest possible flexibility in operation. Both rotaries could be run in multiple with the batteries, or both rotaries could be run in multiple, feeding into the line, and the excess of current used to charge the battery; or one rotary could be run on the line and the second rotary used to charge the battery independently. This last method of operation was found impracticable. Under this condition, when the two rotaries were running on different voltages, the pumping would immediately begin, and it necessitated giving up this method of operation. Notwithstanding the above-mentioned difficulties, when a year ago it was decided to increase the direct-current machinery, a 400-K-W. rotary was purchased rather than a direct-current generator.

The third rotary, when tested, proved to be free from any tendency toward pumping, either when operated from the steam plant or from the water power, and was in every way as nearly perfect as a machine could be. However, when thrown on the line with the two other rotaries, they immediately began pumping, and it was found impossible to run the three rotaries together. The pumping in a rotary system seems to be cumulative; it is very easy to stop it if the proper remedy is applied as soon as the first tendency to pump is noticed. If allowed to go on it quickly gets beyond control. The impossibility of running the three rotaries together necessitated some change, and copper strips were attached to the pole-pieces of the 400-K-W. rotary, which entirely overcame the difficulty. The system now works perfectly, whether operated by steam or water power, and even under the trying conditions of running the rotaries under different voltages, two feeding directly into the line and the third independently charging the battery, no trouble with pumping is experienced. In all other respects the rotary transformers have been all that could be asked for; they have run practically continuously night and day for nearly three years and have had practically no repairs, the commutators simply being turned down once or twice a year.

With storage batteries one looks for frequent renewals of plates. The Hartford battery has had its share of renewals. The battery was bought under a five-year guarantee, which has since been renewed for five additional years. The renewals have not been in excess of what was expected, and no investment of the company has been considered more satisfactory than the battery. The method of deciding when the battery is to be renewed under the guarantee is perhaps interesting. Whenever any plate or number of plates have lost one-third of the original capacity, they are replaced by new plates. In this way the battery is being continually renewed, and its capacity should never be less than 90% of its original capacity.

A study of charts representing the direct-current output of the station shows that the average load of the rotaries during several periods of 24 hours was over 80% of their rated full-load capacity, while the maximum load on the direct-current system was on one occasion 83% more than the full-load capacity of the rotary transformers.

The advantges of the rotary transformer and battery system to the Hartford company have been very great. With the battery the company has been able to use a great quantity of water power that would otherwise have gone to waste. What would otherwise have been waste water power has been utilized at the peak of the load at the time when power is most valuable. The total output of the water power during the past year was over 90% of the possible output.. When operating by steam, the engines have been run at an economical load, the advantages of the storage battery being nearly, if not quite, as great in connection with the operation of the steam plant as of the water plant.

The regulation of the system is much better with the battery than it could possibly be without it, and the service is much more reliable. The interlocking of the battery with the alternating current by means of the rotary transformers makes the battery act as a regulator on the alternating-current system as well as on the direct. During the daytime on Sundays the entire load, both direct and alternating, can be carried by the storage battery. The battery has frequently been allowed to feed the alternating system through the rotaries.

The transformer and battery station is operated by three men; the superintendent, an expert in the care of batteries, and two switchboard attendants.

The system could, of course, be operated with direct-current generators connected to alternating-current motors. This would necessitate in the place of each 250-K-W. transformer one 300-K-W. motor direct-connected to two 125-K-W. generators, and a smaller motor direct-connected to two boosters. The result would be a much greater investment in machinery, much greater floor space occupied, greater complication and expense of operation and a lower efficiency.

To sum the matter up, experience in Hartford has convinced me that the most satisfactory method of supplying electric energy over a considerable area is from a central power station generating alternating current; the current being distributed to rotary and battery sub-stations at high voltage, and the energy locally distributed on the three-wire, direct-current system.

MOVING A 100-TON BUILDING BY RAIL was recently successfully accomplished by the Burlington & Missouri River Ry., which moved the court house of Box Butte county, Neb., from Hemingford to Alliance, a distance of 20 miles. The building was a frame structure 40x50 ft. in plan and two stories high. It was hauled on four freight-car trucks and held in position by block and tackle secured to gondola cars loaded with coal. The building was moved at the rate of six miles per hour and in six hours after leaving Hemingford it was clear of the track at Alliance. It was taken through two cuts en route, and in order to clear the banks had to be jacked up and supported on timbers.

FORTY THOUSAND HORSE-POWER at the point of delivery will be the capacity of the hydraulic power plant now being constructed at Sault Ste. Marie, Mich., by the Michigan Lake Superior Power Co. The turbines are to be direct-connected to single-phase low-voltage generators which will supply step-up transformers. A mean efficiency of 80% for a range of from three-fourths to full gate opening must be shown by the turbines, which, to allow for losses in the generators, transformers and line, will develop 45,243 mechanical horse-power. The available effective head is 16 ft. and 31,250 cu. ft. of water per second will be required. The mean discharge over the falls is about 70,000 cu. ft. per second. The supply canal and power house of this plant were described in Engineering News, Aug. 4, 1898.

THE THIRD-RAIL ELECTRIC SYSTEM has been put in operation on the Braintree and Cohasset branch of the New York, New Haven & Hartford R. R., which is 12 miles in length.

IMPROVEMENTS OF THE BROOKLYN NAVY YARD costing $6,000,000 are recommended in a report recently submitted to the Navy Department by Rear Admiral J. W. Philip, Commandant of the Yard. The proposed improvements are of various characters. Eight new piers, to cost about $100,000 each, will be built, six of which are to project from the side of what is now known as the cob dock, while two more will extend into Whitney Basin. Two new stone dry-docks, costing something like $1,200,000 each, are also included in the improvements. Each dock will be about 500 ft. long. Congress some time ago appropriated $300,000 to repair timber Dry-Dock No. 2, but an additional appropriation of $300,000 will be asked, with which to rebuild the entire basin of stone. This dock is now damaged by a cave-in and cannot be used. A bridge is to be built from the mainland to the cob dock, thus doing away with the chain ferry. The bridge will cost about $200,000, and be built of steel, with stone piers. The steam cranes for the piers will cross the bridge to the cob dock. Wallabout Channel and Whitney Basin, as well as the entire Navy Yard harbor, will be dredged to a depth of 31 ft. This work is now well under way, Congress having appropriated money to remove 1,000,000 cu. yds. of mud, sand, etc., from the harbor. A machine shop costing, completed with machines and tools, at least $1,250,000, will be another addition to be made. The plans for this work are completed, and bids will be opened on Aug. 12. The building will be 350 ft. wide and 470 ft. long. There will be a chimney 150 ft. high, built of steel and brick. The building will be one story high. The upper half of the sides and a large part of the roof will be of glass, while the other parts of the building will be stone, brick and steel. This structure is to take the place of the building recently destroyed by fire. Over a mile of new railway track will be built. This track will cost $5,000, but the connections for the eight new piers and the big cranes, etc., needed will entail the expenditure of an additional $45,000. A storehouse to cost $100,000 is planned for the cob dock during the year. The $300,000 to do the work has already been provided by Congress, but owing to the great amount of work that had to be done in the yard, this was not touched. Many small buildings are to be erected and a number of new walks laid.

BOOK REVIEWS.

NOTES ON DESCRIPTIVE GEOMETRY, WITH EXERCISES.—By Wm. L. Ames. Third edition. Terre Haute, Ind: Moore & Langen. Cloth; 4½ × 6 ins.; pp. 89; illustrated. 50 cts.

This little book is made up of a series of notes prepared originally for the use of students of the Worcester Polytechnic Institute, the purpose being to harmonize the practices of mechanical drawing and the study of descriptive geometry. The present edition is essentially the same as the previous one and embodies only minor changes tending to clear up any obscurities.

DER BRUECKENBAU SONST AND YETZT.—(Bridge-building, Past and Present).—By Prof. Mehrtens. Ed. Rascher, Zuerich. Paper; 9½ × 12½ ins.; pp. 32; 47 illustrations.

This is a reprint of an address delivered by Prof. Mehrtens before the Technical Society of Frankfort on Nov. 2, 1897, which was first published in numbers 10 to 16, inclusive, of the "Schweizerischen Bauzeitung" for 1898, and now appears in the present form for more convenient use. As the title implies, the author treats of the building of bridges from the earliest times until the present day, and illustrates his discourse with photographic views and brief descriptions of the world's most notable structures in this branch of engineering. The illustrations are well selected and handsomely printed, and provide a gallery of pictures of great bridges, which is well worth securing and keeping. The text is a running description of the various structures mingled with scraps of history and criticism.

ELEMENTS OF GRAPHIC STATICS.—A Text-Book for Students of Engineering.—By L. M. Hoskins, Professor of Applied Mechanics in the Leland Stanford Junior University. New York: The Macmillan Co. Cloth; 6 × 9 ins.; pp. 199; illustrated. $2.25.

This is a revised edition of this treatise on the science of graphics as applied to problems in mechanics generally. Naturally much of the work is given up to the treatment of the graphics of roof and bridge trusses, but it also takes up the broader subject of the graphical solution of mechanical problems generally, as will be seen from the following list of chapter headings: "Definitions—Concurrent Forces;" "Non-Concurrent Forces;" "Internal Forces and Stresses;" "Roof Trusses, Framed Structures Sustaining Stationary Loads;" "Simple Beams;" "Trusses Sustaining Moving Loads;" "Centroids;" "Moments of Inertia;" "Curves of Inertia." The book is without an index.

ENERGY AND HEAT.—By John Roger. New York: Spon & Chamberlain; London: E. & F. N. Spon. Cloth; 4¾ × 6¾ ins.; pp. 36. 50 cts.

This is a handsomely printed book with a pretty red cover, and we can cheerfully recommend it to those of our readers who enjoy making a collection of "crank" books on scientific subjects. The author means well, and he writes fairly well, but he has a very limited knowledge of what he writes about. That little knowledge, which is "a dangerous thing," has led him to write a book in which he expresses his opinion that

the term "latent heat," the measurement of the energy of the thermal unit, and the accepted relations of heat and energy, are fallacious or misleading, and that the economy of the steam engine is very much underestimated.

We quote a few passages to show some of the author's ideas:

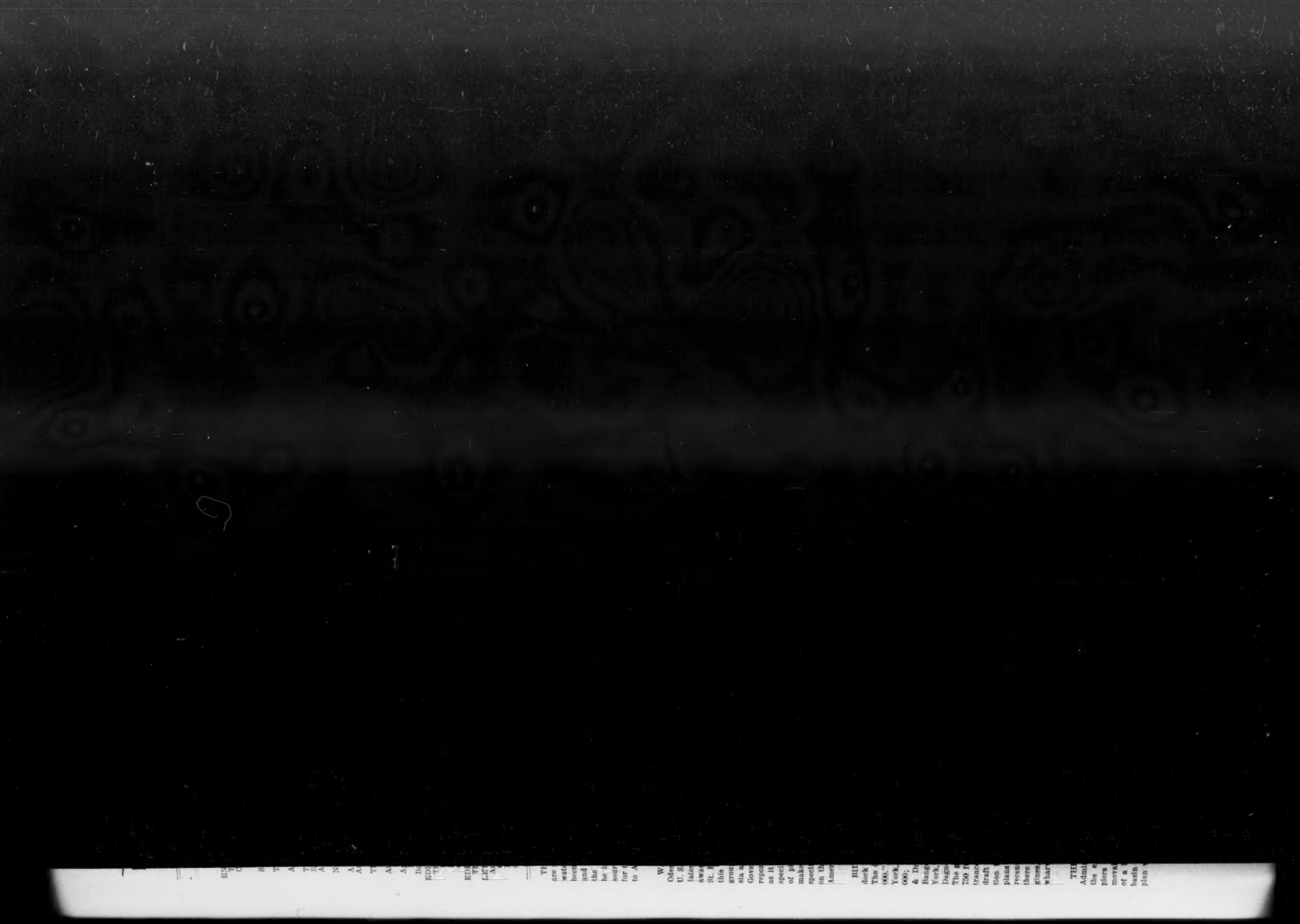
It may be said that heat is elastic and compressible, and we may indicate what is known as "temperature" as being pressure. As the thermometer is a measure of the temperature, or condition, of heat, and not of its quantity or volume, that the heat added to a body without raising its temperature should be called "latent" is misleading.

That heat is not energy or force may be clearly seen by the fact that no amount of heat in a state of equilibrium or uniform intensity or pressure with the heat in all surrounding matter will exert a force in any direction.

It is almost inconcelvable that the energy of the very diminutive thermal unit should be the equivalent of the energy of 1 lb. falling 778 ft., and why it has stood so long unchallenged may be hard to explain.

The author goes into a calculation by which he proves to his own satisfaction that the energy of a heat unit is only 0.78-lb., or about the one-thousandth part as great as the usually accepted figure.

The theory generally held that the consumption of heat energy by the steam engine is enormous compared with the amount of energy delivered in useful work, would appear to be based on the entirely false estimate of the value in energy of the heat unit, together with a confused idea as to the relation of heat and energy.

The steam engine is really a very economical machine, while in generating steam by means of a boiler the loss of heat energy is very great.

We do not regard this author's case as altogether hopeless. If he would retire for a couple of years to a good technical school and take a laboratory course in physics, and study thermodynamics, it is probable that he would be cured of his erroneous views. His book, however, may be of value other than as a curiosity in technical literature; it may be useful to students of heat and of thermodynamics to take up the problems given by the author, which apparently sustain his position, and show wherein lies their fallacy.